



T H E B A N A N A
ITS CULTIVATION, DISTRIBUTION
AND COMMERCIAL USES



HARVESTING BANANAS IN JAMAICA

THE BANANA

ITS CULTIVATION, DISTRIBUTION AND COMMERCIAL USES

BY

WILLIAM FAWCETT, B.Sc.(London)

LATE DIRECTOR OF PUBLIC GARDENS AND PLANTATIONS, JAMAICA; FORMERLY
ASSISTANT, BOTANICAL DEPARTMENT, BRITISH MUSEUM (NATURAL
HISTORY); JOINT AUTHOR OF A "FLORA OF JAMAICA,"
VOL. I; FELLOW OF THE LINNEAN SOCIETY

WITH AN INTRODUCTION BY

SIR DANIEL MORRIS, K.C.M.G., D.Sc., D.C.L., F.L.S.

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FOREWORD

FIFTY years ago all the fruit exported from Jamaica was of the value of £728. The captain of a small schooner trading between Jamaica and Boston made a few trial shipments of bananas, and thus with the aid of Governor Sir Anthony Musgrave and others who followed him was laid the foundation of an enormous industry. Jamaica now exports fruit, but chiefly bananas, of the value of more than a million and a half sterling. Large areas are also planted with bananas in Central and South America, so the Caribbean region is fast becoming the centre for the production of a delicious fruit that is coming into large demand in all north temperate countries. A fleet of splendid white steamers conveys bananas to the teeming millions in the United States, and another equally fine fleet brings cargoes of 50,000 bunches at a time across the Atlantic to the United Kingdom and neighbouring countries.

What Captain Baker, modest and genial man as he was, did for Jamaica, Sir Alfred Jones did for the Canary Islands, and eventually for Jamaica and the Caribbean. Sir Alfred Jones was enabled, with the assistance given by Mr. Chamberlain, to solve the hitherto difficult problem of successfully carrying a perishable cargo of fruit all the way across the Atlantic, first through the heart of the tropics and then, on occasions, through the cold of northern winters, and deliver it in splendid condition for the consumption of the working millions of this country. As aptly stated in a recent speech in Parliament by Mr. Harcourt, "it was no small service to the poor of this

country to have made the banana the common object of the coster's barrow."

As banana planting, after all, is only in its infancy, and even in Jamaica, where the present enormous crops are produced, there are still extensive areas available for extending the industry and new areas are continually being developed in other countries, it is a fortunate circumstance that my friend Mr. Fawcett has been able to see his way to bring together such a large mass of information relating to bananas and present it in so attractive and clear a manner. Mr. Fawcett has been in intimate touch with banana planting for nearly thirty years, and, therefore, he may be regarded as an authority of high standing in all that relates to the details of cultivation and the general management and control of banana plantations.

It is with much pleasure that I find myself in a position to recommend his handbook to all interested in the subject.

DANIEL MORRIS

SEPTEMBER 8, 1913

AUTHOR'S PREFACE

It is not necessary for me to add much to the kind "Foreword" of my good friend Sir Daniel Morris.

I have to acknowledge my indebtedness in the study of the cultivation of the banana to my friends the banana planters of Jamaica, by whose skill and perseverance under difficulties and misfortunes the plantations of the Island have increased to such a marvellous extent. It may be somewhat invidious to give the names of any; but I cannot refrain from mentioning the names of two, to whom I am especially grateful—Mr. Robert Craig and the Hon. Henry Cork.

My thanks are due for many courtesies, and are hereby tendered to the Librarians of the Royal Colonial Institute, the Imperial Institute, the Pharmaceutical Society, and the Botanical Department of the British Museum (Natural History); also to the West India Committee and its secretary, Mr. Algernon Aspinall, for valuable aid in the preparation of this volume; to Mr. H. Hamel Smith, editor of *Tropical Life*; to Mr. A. Roger Ackerley, of Messrs. Elders and Fyffes; to Dr. A. B. Rendle, keeper of the Botanical Department, British Museum (Natural History), and to Mr. Ramsbottom, of the same department.

References are given by footnotes in most cases to sources of information; but sometimes, especially in the case of Diplomatic and Consular Reports and Colonial Office Reports, extracts are given without specific reference, as the source is sufficiently obvious. I have consulted the periodical publications of Agricultural Societies and Departments in all parts of the world, and desire to express

my obligations to the information contained in them, and I wish specially to mention in this connexion those most interesting and useful periodicals, the *Agricultural News* of the Imperial Department of the West Indies, and the *Journal of the Agricultural Society*, Jamaica.

After the following pages had been printed, an important paper by A. d'Angremond was brought to my notice, entitled *Parthenocarpie und Samenbildung bei Bananen*, which appeared in *Beurichte der Deutschen Botanischen Gesellschaft*, xxx. 10, p. 686 (January 1913). The experiments made by him in Surinam confirm the results obtained by myself in Jamaica, that the Gros Michel or Jamaican banana can be made to produce seed—in this case by dusting the female flowers of the Gros Michel (and also the Apple banana) with pollen from *Musa basjoo* and *M. ornata chittagong*. Papers have also appeared in the *Bulletin* of the Department of Agriculture, Jamaica, N. S. II., 6 (January 1913), on Banana Diseases in Jamaica, by S. F. Ashby, and a translation by Mr. Ashby of "The Surinam Panama Disease of the Gros Michel Banana," by A. W. Drost, Assistant, Department Agriculture, Surinam. These papers deserve careful attention, and I regret that I had not an earlier opportunity of reading them.

WILLIAM FAWCETT

OCTOBER 1913

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CHAPTER I

THE PLANT

THE banana is a well-known edible fruit, the product of cultivated varieties of either *Musa sapientum*, *Musa Cavendishii*, or *Musa acuminata*. The first-named is cultivated extensively for the export of the fruit in Jamaica and Central America ; *M. Cavendishii* is grown largely in the Canary Isles, and is generally known as the Canary or Chinese banana ; *M. acuminata* is grown in the Malay Region as well as *M. sapientum*.

In the earliest account of the West Indies, the " bonana," as it was spelt, was clearly distinguished from the plantain (*Musa paradisiaca*) ; but in the Old World, the fruits of these two plants are often both called plantains. The plants are very much alike, but in the fruiting stage they can readily be distinguished by the novice—the fruiting-stalk of banana plants being naked between the fruit and the large purple knob of sterile flowers at its apex, while the fruiting-stalk of the plantain does not lengthen much, and the sterile flowers do not all drop off, so that the stalk is fairly covered. The Chinese or Canary banana is like the plantain in this respect, but there is never any difficulty in distinguishing between the two, as the Chinese banana is a dwarf plant and its fruit is much smaller. The plantain requires much better soil than the banana plant, and a bunch is worth in money three or four times the value of a bunch of bananas. The plantain fruit is much larger than the banana, and is used before it is ripe, cooked—roasted or boiled—instead of bread or potatoes. Plantains are not exported to Great Britain, and only in

small quantities to the United States from Honduras. They are not much wanted in countries where potatoes are plentiful and much cheaper, and they are more valuable than bananas in the countries where they grow.

In a paper on "Bananas from a Commercial Point of View," published in the *Journal of the Royal Horticultural Society*, Mr. Frank Pink makes the following remarks on the kinds of bananas that are sent to Great Britain :

"That grown in the Canary Islands is the *Musa Cavendishii*, which bears large compact bunches of moderately large 'fingers,' and attains a height of about 10 or 12 ft. The plants are fairly hardy, but the fruit is very delicate, and, in spite of its thick skin, is very sensitive to bruising or low temperatures, in consequence of which it is always shipped carefully packed in crates. In flavour it is rich, and is generally preferred to other kinds. This kind is also grown in Barbados, but there it attains greater perfection, and is of finer flavour and more luscious, probably owing to the soil being richer than that of the Canary Islands.

"The variety grown in Costa Rica and Jamaica is the 'Gros Michel,' the plants of which attain a height of 18 or 20 ft., and bear long straggling bunches of large fingers, which are much coarser in flavour than those of *M. Cavendishii*. The plants are less robust than those of the smaller variety, but the fruit is much more hardy, and will stand a lot of knocking about and a moderate amount of cold, for which reason the bunches are always shipped without packing. This is fortunate, for the long bunches require very cumbersome crates to pack them in.

"Another kind sometimes seen here is the 'Claret,' which derives its name from the dusky claret colour of its skin, and which, in my opinion, is the best of all, having a very delicious flavour. The bunches are usually very small, with very few fingers on them; but these, being very large, are well worth the price charged for them, viz. 2d. each. It is possible that this kind may become better known before long.

“Of kinds which are useless for export there are several ; and I have often been asked why one, the ‘Lady’s Finger,’ is not sent over. The reason is that the bunches and the ‘fingers’ of this variety are very small, and the skin of the fruit is so delicate that it is almost impossible to ‘market’ this banana in good condition.

“It is frequently stated that the large fruit seen on the hawkers’ barrows and in the shops is not the true banana, but the plantain. This is incorrect, for the plantain is quite a distinct variety, and is generally used as a vegetable. I have never heard of any being sold here.”

PROPAGATION AND BULB

The banana plant has no seed, but is propagated by young plants which bud from the underground tuberous stem, or “bulb,” as it is called, of an older plant. This bud at first gets all its food material from the parent bulb, but very soon forms leaves and roots of its own. Its first leaves—“sword leaves”—are very long and narrow as compared with those developed later. When the young plant is six or eight months old, it is about 9 or 10 ft. high, and its own bulb is 8 or 10 in. across. This is cut clean away from the parent, and the roots trimmed off. It may be planted as it is, but for convenience of carrying, and to prevent its being blown over before its roots anchor it, it is cut down to within 6 in. of its bulb. This bulb soon shoots, both from the centre and from eyes all round. If a bulb is cut vertically, the eyes or young buds can be traced, clearly showing that the bulb is a stem structure ; it is of large size to provide room for food material which is necessary at first for the formation and growth of leaves and roots. The cut surface looks white and starchy, and in fact the minute cells of the bulb contain grains of starch, just as those of a potato do, and, if required, it could be eaten like a yam or potato, or the starch could be extracted, as in cassava or potato. The stored, stationary food (starch) changes into the

mobile food (sugar), when the bulb absorbs warmth and moisture from the soil ; then growth commences, and the eyes begin to shoot. One shoot takes the lead, monopolizing most of the food supplied from the bulb, and this leading shoot is known henceforth as the plant—the others are its “ suckers.”

THE ROOTS

There are two sets of roots, the horizontal and the vertical ; the horizontal push out in all directions, while others from the base of the bulb grow vertically downwards (Fig. 1). The main roots are fleshy, not forming wood, and are of the same thickness throughout, like stout cords, whereas the roots of rubber, orange, &c., become thicker and more woody the older they are. The growing cells occupy only a small portion in length of the root behind the tip, and the tissue of this part is tender and very intimately attached to the minute particles of soil. The cord-like roots do not branch naturally, but short thread-like roots grow out, and on these, and on the main roots behind the growing portion, are the root-hairs which do the work of absorbing liquid from the soil. Throughout the whole length of these roots there are bundles of fibres running into the bulb, which can be discerned on cutting a root across. These bundles connect the absorbing root-hairs with the leaves. If a heavy wind shakes the stem, the thread-like roots with the root-hairs are torn off, and perhaps even the cord-like roots are broken ; the apparatus for absorbing soil moisture in which the mineral elements of the food are dissolved is destroyed, and the effects are noticed at a later period in the bunches or the fruit coming small.

The roots generally do not seem to have the power of adapting themselves, like the roots of many other plants, to overcoming difficulties. They are not sensitive to anything like the same extent ; on meeting a large stone they do not feel their way under or over it ; they do not respond to the stimulus of obstruction by curving.



FIG. 1. THE ROOTS OF A JAMAICA BANANA PLANT

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The cells grow on, and consequently get crushed and injured. The root dies back a little and then branches, and grows again. If the soil becomes either too wet or too dry, the roots at length decay and the plant falls over ; there is no disease, though, if the soil is wet, the plant may rot.

If the thick cord-like roots are cut through at the tips, it appears to encourage the growth of the thread-like roots ; if they are cut through at some distance from the tip, they burst out at the severed ends into numerous branches of equal thickness, which continue to grow in much the same direction ; the thread-like roots are multiplied by this means also, and in consequence the capacity for absorbing food material from the soil in both cases is increased.

The roots do not approach the surface nearer than about 2 in. ; but if mulching is applied to the soil, the roots may run into the mulch, or very near the surface, and care must be taken to keep the mulch renewed, otherwise the roots will get burnt off. The depth to which they descend depends on the nature of the soil, modified by deep cultivation and drainage ; under favourable conditions, the horizontal roots will be found at the depth of 2 ft. 6 in. from the surface, and the vertical roots from the base at a depth of 4 ft. 6 in. They grow rapidly when the soil is rich and in good tilth, at a rate of 2 ft. in a month for vigorous roots starting from the bulb. I have traced them to a distance of 17 ft. from the stem, but their length depends on the conditions favourable to extension.

The evidence afforded by their structure points to the soil best suited to them—a deep loam, well drained, but retentive of moisture from containing a large proportion of humus.

THE STEM

The underground “ bulb ” is the true stem of the plant. The trunk, or apparent stem, is not a true stem, but

consists of a cylinder composed of concentric layers (Fig. 2), each of which may be traced up to a leaf—the outermost to the oldest leaf—and which are, in fact, the lower portions of the leaves adapted for the special protection of the younger leaves and the flowering stalk. The true stem or “bulb” (properly a tuberous rhizome) is the store-house of food, which may be used in the formation and growth of roots and leaves, but is chiefly of use to the plant in the production of suckers and in the development of the flowering shoot and the fruit. If a sufficient supply of food is not stored up in the bulb when the flowering shoot is in process of formation, the bunch will only bear a few “hands.” Insufficiency of stored material may be due to various causes; the roots may not have been able to do their work properly, the leaves may have been damaged, or new suckers may have been allowed to drain the parent.

In the wild state, when the fruit of a particular plant has ripened and dropped, or in cultivation, when the bunch is cut, the life of that individual is practically over; it does not bear fruit again, but it gives help to the suckers which may be attached to it. Any food left in the leaves passes down into the bulb, and they gradually dry up. The old bulb lasts for some time; it is connected by a large surface with the bulbs of its suckers, and bundles of fibres pass from one to the other. By means of this connexion the younger bulbs draw upon the resources of the parent bulb, slowly and gradually exhausting it of its remaining store.

THE LEAVES

The most striking features about the banana plant are its rapid growth, its early maturity, and the enormous amount of food produced in proportion to the area occupied.* These are accounted for by almost the whole plant being composed of leaf-structure.

* Banana, 242,000 lbs. of food per acre; potatoes, 4000 lbs.; wheat, 2000 lbs.



FIG. 2. A BANANA PLANT WITH THE TOP CUT OFF

Reproduced from a photograph by Mr. J. M. Keith. This shows a banana plant the top of which was cut off before the flower-stalk had grown to the height of the cut. The flower-stalk continued to grow, emerging above the cut, and eventually forming fruit. The cut surface shows the concentric cylinders which form the trunk, each of which is the basal portion of a leaf,

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Compare the leaves with those of the coco-nut, which are divided into ribbons, offering no resistance to wind, and seeming to enjoy the stormy gales of the seashore. The undivided leaf of the banana shows very clearly that it was developed under conditions where only gentle breezes lazily move it, and as the structure of the root points to a forest soil as the cradle of the family, so the leaf indicates an open glade sheltered from the rough winds by surrounding woodland. Naturally a windy situation is not the best, if large bunches and good fruit are desired, and the crop becomes more precarious in proportion as the plants get heavier and more top-heavy with ripening bunches.

The young leaf, before it expands, is so rolled round on itself that not a drop of rain can penetrate to the centre of the cylindrical trunk, where another young leaf or the bunch is forming; when it at length expands, another convolute leaf is there on guard. The last leaf to appear before the flowering stalk is much smaller than the rest, and it hangs over and protects the flowers from the direct sunlight.

As has been already indicated, the sheathing bases of the leaves act the part of a woody stem in supporting the huge leaf blades and carrying them upwards towards the sunlight. They also enclose in their centre, and protect, the flowering stalk for the few weeks while it is pushing its way up from the bulb to the top of the trunk.

The sheaths, when cut across, show very large air spaces, and these are connected with minute pores on the lower surfaces of the leaves which admit air, a large quantity of which is necessary for the rapid growth.

It is interesting to note how the leaves adapt themselves to sunshine and shade. When the rays of the sun are perpendicular and too intense, the sides of the leaf collapse and hang together, the under surfaces, on which the vast majority of the minute pores are situated, coming together and preventing too great evaporation. In wet weather,

on the other hand, the upper surface of the leaves becomes concave.

In an allied plant, the "traveller's tree" (*Ravenala*), it is well known that it is possible to get a drink of water by piercing the hollow leaf stalk; and in a similar way the banana leaf collects the rain-drops of a shower and conducts them along the fluted leaf stalk into the interior of each concentric sheath. Each leaf provides for its own sheath, but the central space, where the young growing leaves or the flowers are pushing their way upwards, is protected. Water supplied in this way, and quite independent of the amount at the roots, is important for the proper "shooting" of the flower stalk; it causes expansion of the trunk and relieves the pressure on the central space. An observant planter noticed that in dry weather a shower of rain seemed to start his plants shooting, and when he found this process hanging fire used to spray his bananas with a hose in imitation of the beneficent shower.

The function of the leaves is to provide food for the requirements of growth in the plant. The energy or motive power necessary for the work of manufacturing the food is obtained from the sun's rays by means of the green colouring matter. The water absorbed by the roots, containing nitrogenous and mineral material, is carried up to the leaves, and a union of these elements with the carbonic acid of the air takes place. The manufactured food is transferred to any part of the plant where growth is taking place, or, if not required for growth, it is stored up in the bulb in the form of starch grains for use later. The green colour of the trunk shows that it is also taking part in the manufacture of food.

THE FLOWERS

If the flowering stalk (inflorescence) is examined in the embryonic condition in the trunk, it will be found that the flowers are arranged in clusters disposed spirally



FIG. 3. A BANANA PLANT

Drawing of a banana plant, showing the large ovaries of the female flowers, the small ovaries of the neuter flowers, and the bracts covering the male flowers. From an engraving by G. D. Ehret in "The Natural History of Barbados," by the Rev. Mr. Griffith Hughes, A.M., London, MDCCL.

round the axis. The clusters at the base of the stalk become the "hands" of the fruiting bunch. It will be found that the flowers in different regions of the stalk vary in the proportion of the length of the ovary (the future banana) to that of the rest of the flower. In those clusters which eventually become hands, the ovary is two-thirds the length of the whole flower; higher up on the stalk are clusters in which the ovary is about one-half the length of the flower; and still higher, there is another series in which the ovary is about one-third of the flower. These three sets of flowers, clearly distinguishable by the different proportionate length of the ovary, are physiologically very different: those with the long ovary are female flowers and become the fruit; those with the short ovary are male flowers; and those with the ovary about half the length of the flower are hermaphrodite (male and female) flowers or neuter flowers (neither male nor female), and form short useless fingers in the bunch (Fig. 4, *ab*). The problem of increasing the number of hands in the bunch must be attacked at a stage earlier than its appearance in the embryonic condition described.

Each cluster has its own covering or "bract," which fits closely over it and over the rest of the flowering stalk, until the flowers of the cluster to which it belongs are mature, when the bract falls.

In some allied species the flower stalk (inflorescence) remains upright, but in the banana and plantain the bunch hangs down on emergence from the trunk. The floral envelope and stamens drop from the female flower, and the ovaries—the future fruits—gradually turn upward. The effect of the pendulous habit with reversed upright fruit is to increase the flow of sap into the fruit.

When the embryonic flowers are first recognizable as such, the flower stalk is a short projection at the apex of the bulb in the hollow base of the trunk in its interior. The formation of flowers only takes place when growth in height, and also of the leaves of the plant, has practically come to an end, and when there is sufficient stored food

in the bulb to provide for the active growth of the flowering system. The actual length of time which is necessary from the first planting of the bulb until the period arrives when the plant commences flower formation will vary according as the conditions for growth have been favourable or otherwise. But probably the time may be safely put down as somewhere between seven and nine months. The period of flower formation may be considered, from the planter's point of view, as the critical point in the life-history of the plant; for it is at this period that the number of hands in the future bunch is irrevocably determined. If the store of food in the bulb is ample, the bunch will be a large one; if meagre, the bunch will be small. No amount of manuring or irrigation, applied after this period, can possibly affect the number of bunches, although such assistance may be necessary for the welfare of the plant and its bunch, and for the size of the fruit.

It is difficult to determine the length of time that elapses between the first definite formation of flowers at the base of the trunk and its appearance on emerging—the “shooting”—from the top. Doubtless the time varies considerably under different conditions, and may possibly be as short as one month or as long as two months. Probably an ample provision of water, both at the roots and into the trunk from above, will considerably hasten the shooting.

The usual time for the banana to shoot may be put down as ten months from the planting of the six to eight months old sucker.

The extreme end of a bunch of bananas, as it hangs from the plant (Fig. 4, *m*), consists of a large number of flowers, tightly enclosed by large, claret-coloured bracts. There are several flowers together in a small cluster under each bract. All the bracts, except the uppermost, are very firmly closed over the flowers, overlapping one another. The uppermost bract (Fig. 4, *b*), like the upper shell of an oyster, rises on its hinges. The cluster of

mature flowers within this bract can then be visited by insects for the honey and pollen. The bract has now



FIG. 4. BANANA IN FRUIT

m, male flowers covered by bracts ; *b*, bract ; *l*, portion of stalk from which male flowers have dropped ; *ab*, neuter flowers.

done its work of protecting the flowers and soon falls; the flowers also drop, the next bract rises, and this process continues indefinitely until the bunch is cut. There is,

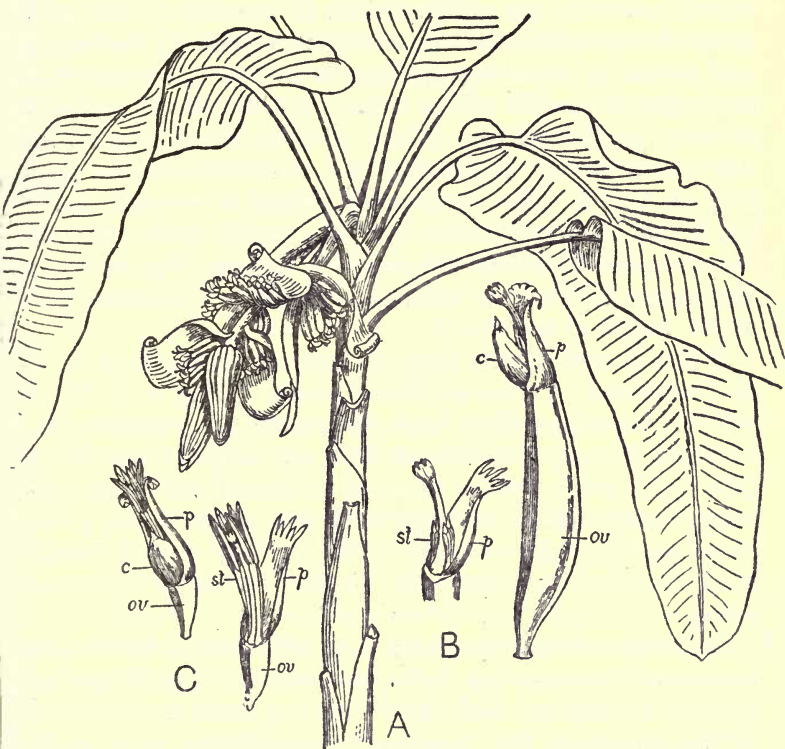


FIG. 5. A FLOWERING STALK

A, Flowering stalk (inflorescence) of banana, just emerged, before the bracts covering the flowers have dropped. B, Female flowers. C, Male flowers. *ov*, ovary; *st*, stamens; *p*, five-lobed perianth (three segments of calyx and two of corolla); *c*, inner portion of perianth (being one segment of the corolla), the free petal.

therefore, a long piece of stalk hanging below the bunch without bananas or flowers, from which bracts and flowers have already fallen.

There are five stamens (Fig. 5, C, *st*) bearing pollen in each of these male flowers of the banana; in the Abyss-

sinian banana (*Musa Ensete*) there are six stamens; in the allied Wild Plantain (*Heliconia Bihai*) the sixth stamen is more like a petal than a stamen. In most species of *Musa*, however, the sixth stamen is wanting. The parts of the flower of the banana which correspond to the sepals and petals in more regular flowers are so combined that the larger piece of the floral envelope, the perianth, consists of three sepals and two petals, all united together, an indication of which is given in the five lobes at the apex (Fig. 5, C, *p*). The third petal, which in orchids is the lip, is not attached to the rest (free petal), and is shorter than the combination of sepals and petals (Fig. 5, C, *c*). The ovary (Fig. 5, C, *ov*) is one-third or one-fourth the whole length of the flower.

If the flowers which later on become the banana fruits are examined as soon as they "shoot" (Fig. 5, A, B), it will be seen that they have the same general structure as those already considered, but are larger: the ovary (Fig. 5, B, *ov*) (later the banana) is much more developed, being two-thirds of the length of the whole flower; the stamens (Fig. 5, B, *st*) are defective. These are the female flowers which in the wild species of *Musa* produce seeds.

In plants related to the banana (*Musa*) the flowers are hermaphrodite, having both stamens and pistils perfect in each flower, and from this fact and from the structure of the flowers in the species of *Musa* there is no doubt that the original plants from which they are all derived had all the flowers hermaphrodite, and that the pristine character has developed into the modern condition where some flowers are only female and others only male, while a remnant intermediate in position are apparently hermaphrodite or more probably neuter. The significance of the evolution in structure is that cross-fertilization is of use to the plant. Moreover, the female flowers being mature before the male on the same plant shows that this is a case of necessary cross-fertilization from another plant—that the pollination of the female flowers under natural

conditions in the wild state is carried on by insects carrying pollen from one plant to another.

As part of the ovary, namely, the pulp, is of value for food, it is advantageous to those who want the food that there should be no fertilization and consequent formation of seeds to which all the valuable constituents of the sap would go instead of to the pulp. It is, therefore, fortunate from the point of view of a food-supply that there appears to be some difficulty in the way of insects pollinating the female flowers of the banana plant. The neuter flowers may be compared to the vestigial structures occurring sometimes in nature, which have lost their utility under modern conditions and have become more or less atrophied.

THE FRUIT

It takes from two and a half to four months after shooting before the fruit becomes "full," *i.e.* attains full size before ripening (Fig. 4).

For local use it is considered that fruit has a better flavour if cut when "full" and allowed to ripen hung up, rather than if it is left to fully ripen while still attached to the plant. For export, consideration has to be given to the time that will be taken on the voyage, and naturally fruit must be cut much earlier for a voyage of twelve or thirteen days than for one of only four or five days. The earlier it is cut before becoming "full," the greater the want of flavour and ripe consistence. The aim of inventors of methods of storage of fruit should be directed towards arresting all chemical change in the fruit; if such a method could be perfected, the fruit need not be cut until it is "full," and the true flavour would be developed on ripening.

ORIGIN OF SEEDLESS VARIETIES

The fruit does not produce seed in the cultivated varieties, and on this point several questions may be raised for consideration: What was the origin of seedless

varieties? Do the cultivated varieties ever produce seed without the intervention of man? Is it possible for cultivators to make their plants seed? Could varieties be raised from seed with fruit of improved flavour or better keeping quality, or varieties immune from disease?

As to the origin of seedless varieties of fruit, there are several species of *Musa* of which the fruit has no pulp, but consists merely of the outer shell and large seeds filling up the shell like a pea-pod and its seeds, the peas; other varieties have a small amount of pulp. The pulp is of greater value in this case as food than the seeds. Primitive man, whose food was precarious, was always keen in the matter of selecting food-plants and preserving varieties that were promising, and no doubt took care of the suckers of a banana which yielded pulpy fruit, just as the Arabs grow suckers from date palms that are known to bear good fruit. The selection would be continuous, and whenever a variation occurred with a larger amount of pulp and a corresponding fewness of seeds, it would be carefully treasured and the suckers planted instead of those with little pulp and many seeds. There is no difficulty whatever in understanding how the seedless banana has arrived, nor in understanding how varieties of the seedless type have occurred and been propagated from time to time. An improvement on the ordinary fruit occurred in Martinique, and eighty years ago M. Jean François Pouyat, although he may not have been the first to notice it or the first to propagate it, was yet sufficiently alive to its importance to introduce it into Jamaica.* This variety, called at first the Pouyat banana, or the Martinique banana, has become the only one that is cultivated in Jamaica, Costa Rica, and elsewhere for export, and is known now as the Jamaican or Gros Michel banana.

Quite lately specimens of a sport of the Canary Banana (*Musa Cavendishii*) have been received by the writer from Dr. G. V. Perez, of Teneriffe. The sport is about double

* *Bulletin of the Botanical Department, Jamaica*, vol. viii. pp. 155-6 (1901).

or treble the height of the ordinary dwarf kind; the flowers have been examined by the writer and are identical with those of the typical plant; but Dr. Perez considers the fruit somewhat larger and better. This sport appears here and there in the plantations without apparent cause, and is called by the natives the "male" banana. Suckers grow up like the parent sport. It is possible that many or all of these tall bananas are from suckers of the original sport, which have been planted inadvertently with the ordinary kind, but there is no explanation of the first appearance. At the suggestion of Dr. Perez the sport may be known as *Musa Cavendishii* forma *Sagotiana*,* after Dr. Sagot, his friend and his father's, who wrote so learnedly on the banana many years ago.

Another sport of a different kind was reported from Grenada by Mr. W. Malins-Smith in the *Agricultural News* (vol. vi.): "A few days ago I picked a bunch of 'claret' bananas which contained two hands of green-coloured fingers and one hand of both claret and green fingers. There was one finger which was half green and half claret. The green fingers ripened yellow. The bunch when ripe presented a very curious appearance."

Many botanists have supposed that plants that have been propagated for immense periods of time without having recourse to seed have thereby lost the power of producing seed,† and it was important to ascertain if it was so with the banana.

It would be of considerable interest, and possibly of very great commercial importance, if the cultivated banana could be induced to produce seed like the wild species. Instead of having to wait for the uncertain chance of sports, one of which might possibly occur in a cycle of

* Characterized by its remarkably tall stem.

† "It is notorious that many cultivated plants, such as the banana, pineapple, bread-fruit, and others previously mentioned, have their reproductive organs so seriously affected as to be generally quite sterile."—"Variation of Animals and Plants under Domestication," by C. Darwin, vol. ii. p. 268 (1868).

1000 years, numerous varieties could be continuously raised, and a selection made of such as seemed promising.

Numerous experiments were carried out at Hope Gardens, Jamaica, with this end in view. Cross-pollination is easy enough to carry out, and the experiments were made under varying conditions in soil, in water supply, &c. No success was obtained in a great number of experiments by using the pollen of the Jamaican banana, and at last the pollen of the red banana (var. *rubra*), dusted on the stigmas of the ordinary cultivated banana, led to the production of seed. Unfortunately the hurricane of 1903 levelled the banana plantation before the seeds were ripe, and the experiments were for the time abandoned. It was thus definitely proved at Hope Gardens that the female flowers which produce the commercial banana have not become sterile after ages of vegetative reproduction of the plant, but are capable of producing seeds.

If experiments are made again, it is suggested that pollen be used not only of the cultivated varieties, but also of distinct species with edible fruit.

As far as could be ascertained, the pollen of the common Jamaican banana was quite inert on female flowers of that variety. But it was not proved that this was due to sterility in the pollen itself. Experiments might be made to determine whether this pollen is fertile by using it to pollinate the female flowers of some of the seed-bearing species. It is well known that pollen is inert in many species on flowers of the same plant, although fertile on flowers of another plant of the same species. This may be the case with species of *Musa*. Now, as seedless cultivated bananas are propagated by off-shoots (suckers) they are practically all derived from one individual, and many varieties are only sports from the same individual stock; if the pollen is inert on the same individual, it would naturally be also inert on all plants derived, however remotely, from that individual, even although they may have sported.

On the other hand, the plantain (*Musa paradisiaca*) is no doubt descended from a different individual. Hence the pollen of the plantain might be effective in producing seed in the banana. Pollen from species producing an edible fruit might also be tried. A description is given in Chapter XXXIV of the species of *Musa*, indicating those which bear edible fruit; pollen might be used from any of these to pollinate the female flower of the banana.

It is not much more than a quarter of a century ago that Messrs. Harrison and Bovell discovered in Barbados that sugar-cane produced seed. That discovery came most opportunely about the time that the Bourbon cane became so subject to disease, and the selected new varieties raised from seed were to a great extent immune, and also in some instances gave larger yields of sugar. This shows the importance of experimenting similarly with the banana.

O. W. Barrett states * that "the following directions for causing a banana to produce seeds were given by a Porto Rican native: Get a stool of bananas growing rapidly in shallow soil by the addition of artificial fertilizers; let one bunch of fruits 'set,' but before that ripens cut down all but one of the stems in the clump; the remaining shoot, 'thinking it has but one more chance to perpetuate its kind before being killed,' on account of the tremendous shock to the more or less connected stem bases in the clump, at once produces a small bunch of somewhat abnormal fruits some of which will contain genuine seeds. As a matter of fact, it is a usual thing to find seeds in the commonest of the Philippine bananas, the *Saba*."

* *Philipp. Agri. Rev.*, v. 383 (1912).

† A paper by A. d'Angremond on experiments in Surinam, appeared in *Ber. Bot. Ges.*, xxx. 686, while these pages were in the Press, in which it is stated that while in the Canary, Jamaican, and Apple bananas fruits were produced without pollination, the use of pollen was necessary for the production of fruit containing seeds in *M. basjoo* and *M. ornata*. Most of the pollen of the Jamaican and Apple bananas was sterile, and only a few of the ovules in these plants have an embryo-sac. However, the dusting of the ovaries of these cultivated fruit plants with pollen of *M. basjoo* and *M. ornata* was sufficient to produce seeds.

CHAPTER II

CULTIVATION. GENERAL OPERATIONS. PREPARATION OF LAND. CLEARING. DISTANCE. DIGGING HOLES

THE chapters on cultivation that immediately follow concern the banana grown so largely for export in Jamaica. The experience summarized here extends only to its cultivation in that island, but the soil and climate differ so remarkably in different districts that much of what there is to say on the subject in connexion with that colony will probably apply to its cultivation elsewhere. When the banana industry in other lands is under consideration, notes on the cultivation, as practised locally, are included.

It will be observed that there are no hard-and-fast lines, no definite directions that can be formulated for the cultivation, but that the cultivator himself must thoroughly study the plant as well as the soil and the climate, and that he must be for ever experimenting in order to increase his knowledge of the behaviour and capabilities of the plant in each field of his cultivation. These chapters must be taken only as suggestions for experiments towards acquiring an exact acquaintance with the plant under strictly local conditions ; the more completely these are carried out the greater will be the ultimate success attained.

GENERAL OPERATIONS

The following is a condensed general statement of operations on the north side of Jamaica where the soil is a heavy loam, 9 to 15 in. deep, with a stiff clayey subsoil and a rainfall of 90 in. :

For plants, start in January, plough 9 in. deep, throwing a furrow 14 in. wide. This plough will require a team of eight cattle to pull it. Two ploughs will do three acres a day. Harrow, and allow it to lie fallow till first week in March; then plough and cross-plough 6 in. deep, and

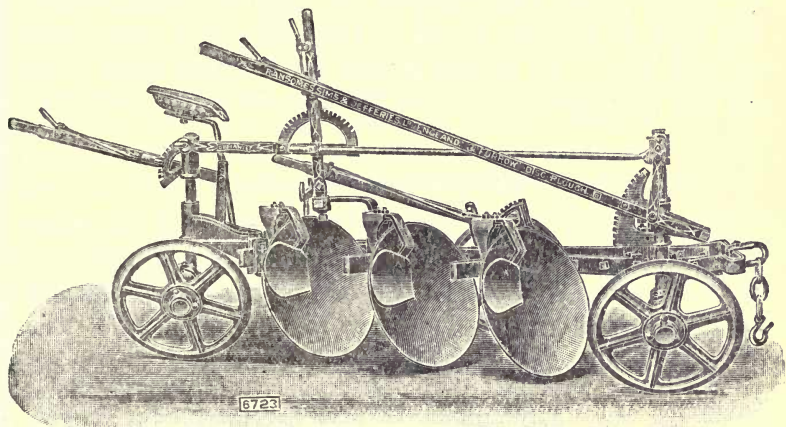


FIG. 6. A THREE-FURROW DISC PLOUGH USED IN JAMAICA

harrow. Line 14 ft. square. Dig holes 2 ft. 6 in. every way, and fill in with surface soil.

Dig suckers, beginning first week in February, one month before they are wanted, and only digging each week what can be planted each week a month later. Plant the second week of March to the end of April. Keep stirred with the plough 3 to 4 in. deep in fine weather, say every eight weeks, but in wet weather simply cut down weeds with cutlass. Select the strongest shoot for the plant, which will fruit in the following February or March.

Prune off all suckers until June, then leave one sucker just coming out of the ground, which will fruit in the following April. In October leave another on the opposite side of the stem, which will fruit the following spring twelve months. In February leave another, which will fruit in fifteen or sixteen months.

On such an estate 66 to 70 per cent. of plants and 88

to 90 per cent. of first ratoons should give bunches.* Taking a seven-year period, the yield should be 330 payable bunches per acre per annum.

On the south side after lining at 15 ft. by 15 ft., the irrigation canals would be laid out and water supplied to young plants every five or six days, to ratoons every ten days, at the rate of two to two and a half cubic yards to each acre. No plough is used for the first three years on this light soil, but instead the hoe and the Assam fork.

PREPARATION OF LAND

Clearing.—In ground covered with forest or woodland some are content to cut down and burn, leaving the stumps to decay; but it is better, if it can be done, so to cut the trees that they will tear up their roots in their fall. The trees should be carefully selected, marked and cut up for their special uses—timber, posts, piles, tramway sleepers, firewood, &c. The underwood and brush can be used to burn up the roots and the trunks of useless trees such as Guango, Bastard Cedar, &c.

The ground should finally be carefully stumped. Machines, *e.g.* Trewhella's "Monkey Winch," can be obtained which facilitate the work of stumping. Even if the land is virgin soil and does not require ploughing, it is better to stump at first. The plants can then be put in at regular distances at once, an important matter in many ways; and if ploughing is necessary at a later period, there is no delay caused by digging out stumps. Stumping also facilitates cutting and carrying the fruit.

If the land is not the virgin soil of a forest, and especially if it be old cane land or pasture, it should be first thoroughly ploughed at least 9 in. deep and harrowed. If the situation is on hill-sides where the plough cannot be worked, the pick-axe for stony ground and the fork for soft ground should be used.

* "Bunches," "payable bunches," and "straights" are terms used to signify bunches of nine hands and over.

Distance.—The usual distance is 15 ft. by 15 ft. or 14 ft. by 14 ft., but these distances are modified according to circumstances, and planters are continually trying experiments with other distances. One planter stated that a hill-side of fifteen acres on the north side, planted 8 by 8, yielded 8000 straight, or more than 500 to the acre. Another in a hot flat district on the south side found it advantageous to plant 8 by 8 in order to shade the ground as soon as possible. It is stated by the advocates of close planting that the crop comes in sooner, that it can be regulated with greater success so as to come in during the five months of high prices, and that less weeding and less water are required. On the other hand, it will be found necessary to remove every alternate row for first ratoons, and probably for third ratoons to reduce the field to stems at distances of 16 ft. by 16 ft. Where there is too much shade, the tubers are apt to grow gradually higher out of the ground with less hold against the wind, and the plants run up with a weak stem and irregular bunch. Another system is to increase the distance between the rows, and decrease it between the plants in the row, making the wider intervals run north and south. A planter who reaped 330 payable bunches per acre, planting 14 by 14, got a yield of 400 per acre when he has planted 10 ft. by 10 ft. It is, however, generally advisable to keep to a distance of 15 ft. by 15 ft. or 16 ft. by 16 ft., but experiments with other distances may be made on a small scale. In utilising the banana for shade for cacao, the plants may be put in 15 ft. by 15 ft., or perhaps better still 16 ft. by 16 ft. with the cacao in the same line. If the cacao were planted in the centre of the square, ploughs and cultivators could not be worked either way, but by planting in the same line as the banana, they can be used for two or more years without apparent injury to either plant.

H. Q. Levy writes*: "I would advocate the following distances, either of which will give good results: 14 by 14 ft., planting two separate suckers to each hole,

* *Journ. Jam. Agric. Soc.*, xvi. 74.

which gives 222 holes or 444 suckers ; and 11 by 11 ft., with a single sucker to each hole or 361 per acre. If an attempt be made to grow over 450 suckers per acre, although the land may be so fertile that there is a good proportion of straights, and there might be a chance of reaping the plant crop during the months of high prices, it will invariably be found that the ratoons are away out. Planting at 10 by 10 ft. I could never recommend, but 15 by 15 ft. or 16 by 16 ft., carrying three suckers per stool, may be practised with success on the St. Catherine plains, but with the aid of irrigation."

With reference to the subject of distances between plants, a friend writes :

"In wide planting there is less risk of a falling tree carrying another with it. The roots of the banana appear to require a radius of at least 8 ft., and wide planting has always commended itself, in my experience, as the best agriculture ; that is to say, sufficiently wide planting to give the plant or tree space admitting of its full and best development. Among other advantages cultivation is easier ; and beyond question the higher the cultivation the better is the fruit obtained."

Digging Holes.—Some planters are content with shallow holes about 1 ft. deep. But better results are obtained when holes 2 ft. 6 in. every way are dug ; the roots get a better start and a better hold on the ground, so that the plants are more forward and are not so liable to be blown down.

A planter who prepares holes 3 ft. to 4 ft. wide and from 2 ft. to 2½ ft. deep, writes : "It is not always possible to get the labour to make these holes, but I am convinced of the advantage and ultimate economy of making them large and deep : among other reasons, the plant gets a start at once ; a good root is formed in the loosened earth which practically 'anchors' the tree, and enables it to resist high winds, and when planted in this way the tendency of the root to come to the surface is greatly obviated."

CHAPTER III

PLANTING. TIME OF YEAR. SEED-SUCKERS. PREPARATION OF SUCKERS

PLANTING

Time of Year.—There is no doubt that, in districts favoured with rich soil and good seasons, March is the ideal month for planting. All vegetation is then springing naturally; showers during the following month help to start the eyes of the bulb in putting out leaves and roots, and when the May rains come the young suckers rush along faster than at any other time of the year. In districts not so favourably situated, planting is done in January or February, for the American market from March to June.

Seed-suckers.—The best for general purposes in planting are “maiden suckers,”* that is, suckers about eight months old which have taken on adult foliage, and passed beyond the stage when the leaves are narrow in proportion to their length—“sword-suckers.” They are cut down to within 6 in. of the bulb, where they measure 8 to 14 in. across the cut surface. The heart eye should be destroyed, all the outside eyes cut away with the exception of the largest and fullest, and the old roots cleared off. If the heart eye is not destroyed, there is a tendency to form a new bulb on the top of the old one and the plant is then very easily blown over; besides there is the risk when the sucker is from eight to ten months old that the bunch is already formed, in which case it will probably turn out to

* H. Q. Levy in *Journ. Jam. Agric. Soc.*, xvi. 74.

be only of six or seven hands. A maiden sucker should be planted upright, and the hole must be of sufficient depth to allow the eye to be buried at least 8 in. below the surface.

Sword-suckers are used in supplying "gall" spots in established fields, and for planting the outside rows of land adjacent to woodland. They should be between 6 and 8 ft. high, planted in an upright position, with all the leaves trimmed off except the unopened heart one.

On *moist* soils "sword-suckers," cut down to within 8 in. of the bulb, may be used. The bulb is placed flat on its side in the hole.

Suckers to be used for planting should be most carefully gathered, and this is not always easy, when they are dug from stools growing in stiff clay soil. The utmost care should be taken not to bend the soft part of the sucker just where it joins the bulb, for any sucker injured in this way is worthless.

Preparation of Suckers.—Some planters put the seed-suckers in the ground at once; others leave them to dry for three or four days, and then plant. Others again find that they get better results by piling them in heaps 8 to 10 deep, then trash is thrown over them to keep off the sun, and they are left a month. The best way to pile them is to erect fences 3 ft. 6 in. high to enclose a convenient spot 6 ft. wide and of any length necessary. It is, however, better to plant at once, if the suckers are in good condition. The real reason for leaving them for a month is when they are inferior, and it is necessary to determine which have growing-eyes.

CHAPTER IV

IRRIGATION AND DRAINAGE

IRRIGATION

THE water channels should be close to the suckers when first planted, but when the plants are well established the channels should be made in the centre of the rows, for if the water is applied close to the base of the stem it encourages the production and growth of suckers, and in this way unnecessarily weakens the plant. As already stated, water is supplied to young plants every five or six days, to ratoons every ten days, at the rate of two to two and a half cubic yards to each acre.

DRAINAGE

Perfect drainage is absolutely necessary for bananas. It is even more important to elaborate a system of drains for an irrigation district than to provide water channels, for more harm is done by having too much water than too little. If there is too little water the processes of life go slow, growth may cease for a time and be renewed when water is supplied again without damage being done other than delay in the formation of the bunch. But with too much water the soil becomes water-logged, decaying organic matter in the soil produces a harmful acidity and sourness, and air is prevented from penetrating amongst the interstices of the soil, which is necessary not only for the production of food material, but for the welfare of the root system. For these reasons drains are equally important on clayey soils or subsoils where the water is

supplied by the natural rainfall, and they are quite as important on hill-sides as on flat ground. It might be thought that on sloping ground the rain will drain off naturally without leaving any water to accumulate and become hurtful ; but even so, the soil becomes saturated, and unless drains are made air cannot reach the roots. Forking alone on hilly land will not suffice, for there is the danger of heavy rain carrying off the soil. The drains on a hill-side should be made across the slope, with only just sufficient fall to carry off the water towards that part where the soil is least fertile, and at that part the drains should be deepened and widened, and made horizontal, so as to act as catch-pits for soil and *débris*, which can be dug out and spread as a most valuable top-dressing. If possible, the overflow from such catchments may be got rid of in natural gullies, but care must, of course, be taken not to lose any of the washed material down the gully ; where there is a risk of this, another catch-pit may be made at a slightly lower level than the first, and the overflow taken into it. In making drains it is a great mistake to make them too shallow, from motives of economy ; they should be not less than 2 ft. deep, and sometimes the depth should be more than 3 ft. If the soil of the hill-side is loamy or sandy, catch-pits only will probably suffice.

CHAPTER V

CULTIVATION AFTER PLANTING. MULCHING. EARTH MULCH. DRY MULCH. GREEN MULCH. PLOUGHING

CULTIVATION AFTER PLANTING

Mulching.—Keeping down weeds, maintaining a surface mulch, and loosening the soil are all important matters in the cultivation of bananas, as of other plants. Mulching has, during the last ten or twelve years, been strongly advocated by agricultural authorities in the West Indies.* The dust or earth mulch, the dry mulch, and the green mulch are the forms most commonly employed. The earth mulch is the form that is advocated in America, the surface layer of fine loose soil varying from 3 in. in the eastern United States to 6 or 7 in. in California and the arid regions; the dry green mulches are the forms that have been chiefly used in the West Indies. The principle is that where there is no mulch, the compacted surface layer forcibly abstracts the moisture from the layers below it, and evaporates it from its surface; while the mulch of loose surface soil or of decaying vegetable matter is unable to take any moisture from the denser subsoil, which is therefore protected from evaporation. This is well illustrated by the familiar fact that while a dry brick will suck a wet sponge dry, a dry sponge (corresponding

* See *Bulletin of the Botanical Department, Jamaica*, viii. 54 (1901), and elsewhere; *Bulletin of the Department of Agriculture, Jamaica*, i. 126 (1903), and elsewhere; Hon. Dr. F. Watts, in *Agricultural Report on Dominica*, 1905, and in many Reports since; *Journ. Jam. Agric. Soc.* in many articles and notes.

to the mulch) is unable to take any water from a wet brick. A friend wrote a short time ago : " I have been practising the dry earth mulch (see Macdonald's ' Dry Farming '*) for some time in suitable soils, *i.e.* free sandy loam, and alluvial, which can be ploughed and harrowed at all times except after heavy rains. The principle is sound, and, so far as I can judge, the earth mulch is effectual as far as it can be so. I know others who are trying it with good results."

Earth Mulch.—Surface mulching, which consists in keeping a deep layer of the top soil in a dry, loose, granular state, has two effects. First, by rendering the top layer more porous, or rather by rendering the surface pores larger, it lessens considerably the run-off in the case of heavy showers. Its chief object, however, is to make evaporation difficult by destroying the capillary pores and tubes through which the soil moisture is brought under the active evaporating influences of the atmosphere. " The height † to which at ordinary temperatures water rises in capillary tubes depends entirely on the diameter of the tube. If the diameter is $\frac{4}{100000}$ of an inch, water will rise about 100 ft.; if the diameter is $\frac{4}{100}$ of an inch, the water will rise 1 in.; if the diameter is $\frac{4}{10}$ of an inch, the water rises about $\frac{1}{10}$ of an inch. Now in compact soils the pores form the equivalent of continuous tubes which may be within the range of the foregoing figures. The American experts in their soil surveys have determined the number of particles of many loamy soils. In an ordinary loamy soil they find from two to four billion particles per cubic inch. It is easy to compute from this that the size of the particles may be as low as $\frac{1}{7000}$ of an inch, and we may assume consequently that the pores are of the same order of magnitude. The theory of

* " Dry-Farming in America: being a Report presented to the Transvaal Government." By W. Macdonald. Pretoria, 1909.

† " Rainfall in Relation to Dry Farming." By Rev. E. Goetz, S.J., Director of the Bulawayo Observatory. *Rhodesia Agric. Journ.*, ix. 487 (1912).

capillarity shows that in tubes of that diameter water will rise from seven to eight yards. . . . This upward movement of the lower moisture, though sometimes injurious owing to the accumulation of saline substances, may in a great many cases be beneficial, provided it be stopped before it comes into contact with the surface air. This is what is done by the surface mulching, which for the small pores of the soil substitutes pores of large dimensions through which capillary ascent is insignificant. This mulch acts as a surface covering. The soil should be cultivated after every rain that has been heavy enough to puddle the surface. This cultivation should be resorted to as soon as the implements can be passed over the ground without clogging. If the ground has become so dry that rain falling on it goes only to increase the water film round the soil particles, and does not start a downward percolation, capillary ascent of soil moisture from the lower layers is so certain that soon after such rain the deeper soil has become measurably drier than it was before, while the surface foot is found to contain more water than had fallen upon it. This will in most cases be an advantage, provided surface evaporation be checked as soon as possible."

"A leading question * in connexion with cultivation is the depth to which the soil should be stirred for the best results. Many of the early students of the subject found that a soil mulch only one half inch in depth was effective in retaining a large part of the soil moisture which non-cultivated soils would lose by evaporation. . . . In general, however, the deeper the cultivation, the more effective it is in reducing evaporation. Fortier, in the experiments in California, showed the greater value of deep cultivation. During a period of fifteen days, beginning immediately after an irrigation, the soil which had not been mulched lost by evaporation nearly one-fourth of the total amount of water that had been added. A mulch four inches deep saved about 72 per cent. of the evapora-

* "Dry-Farming." By J. A. Widstoe. 1912.

tion; a mulch eight inches deep saved about 88 per cent., and a mulch ten inches deep stopped evaporation almost wholly."

The Principal of the Lichtenburg Dry Land Station in the Transvaal, according to *United Empire* (February 1913), has just reaped a crop of wheat which has been grown this season without a drop of rain from seed-time to harvest. This result is advanced as signal testimony to the possibility of successful dry farming in the more arid parts of the Union.

Dry Mulch.—Dry mulching is a covering of cut grass or suitable "bush," and Dr. Watts has proved that the prevention of water evaporation from the soil by this means is more important than any system of artificial manuring. It takes * three or four acres of good Guinea grass to mulch one acre of bananas. The grass should be wilted in the sun for a few days before handling. Wherever the mulch rots down so as to expose the soil, it must be immediately renewed.

Mr. Barclay writes in *Journal of the Jamaica Agricultural Society* (November 1910): "There are bananas now being grown on soils and in climates that a few years ago would have been deemed absolutely unsuitable to grow bananas commercially. Bananas of as good grade as anywhere else are grown now in the red soils of St. Ann, and in the rather dry soils of Trelawney, with a low rainfall. These soils are first thoroughly forked, and then immediately mulched heavily with Guinea grass. It costs about £2 10s. per acre per annum to keep the plants mulched all through to the depth of a foot or more, but then there is little, if any, weeding to be done, and no forking for as long as two years. Only when the bananas are grown out of the soil forking has to be done, and the mulch turned in. The surface mulch keeps the ground soft, and cool, and moist, so that in these rather dry climates the expense of the production of bananas is not greater in the end than in districts of heavy rainfall."

* H. Q. Levy in *Journ. Jam. Agric. Soc.*, xvi. 248 (1912).

Green Mulch.—"A great deal of the expense of weeding and forking in wet districts can be avoided by growing heavy green mulches, as a dry mulch does not last long nor act as well there. Then there is the additional profit in growing or adding a mulch, in the land being constantly made richer rather than becoming poorer. Jerusalem peas [*Phaseolus trinervis*] can be planted immediately the plants appear and the ground is thoroughly forked. The vines will soon cover the ground, and they do not run so much as the velvet bean or the Bengal bean, so causing expense in keeping the vines within bounds, and at the same time the Jerusalem peas last longer than cowpeas, so are found to suit better as a more permanent mulch. No matter when planted, the Jerusalem peas only blossom about October, so if planted in February or March, when the bananas are just in, they will cover the ground till December."

In the *Journal* for April 1910 he writes: "For ten years we have patiently written of the various legumes which ought to be utilized for the triple purpose of (1) covering the land with a plant under control to keep down and crush out weeds; (2) providing a cheap mulch, as mulching material which has to be cut and carried on the land is often difficult to get in quantity, and is expensive to apply—this thick covering of vine should be cutlashed down when in blossom and let lie until it rots, when it can be forked in; (3) supplying humus and nitrogen. In a tropical country where such heavy rains may fall and cake the earth mulch, beat even newly forked soil hard, and wash the soft top soil into the open drains, or away into water-courses, the green mulch is the practice that should prevail. As soon as the banana suckers are planted, get the soil covered, so that the rains will not beat it or wash it, or the sun bake it." Jerusalem peas grow well even in the shade of a banana plantation, and are very effective in keeping down weeds. The growth is thick and on an average 2 ft. high.

Ploughing.—Various opinions are held by banana

planters about ploughing. Some who have planted in light, loamy soils have been reaping excellent crops for some years without any ploughing. Others, with heavy soil, plough every eight weeks with a 6 in. plough, alternately one way and across. Others, again, plough only once a year. With heavy soil in wet districts forking has now become the custom instead of ploughing.

A friend who established a cacao walk with bananas, before planting, ploughed, cross-ploughed, harrowed, and, when necessary, trenched; afterwards he ploughed with a small plough (with moon coulter attached) three to six times a year. On banana lines, where a plough cannot work, he forks occasionally and hoes frequently. He says that the plough is far more effectual in breaking up the soil than any other implement he has tried, and it keeps the land clean much longer. The plough works from 4 to 6 in. deep, and the cultivator 2 to 3 in. Another planter forks once a year, and uses the cultivator to keep the weeds down. When the grass is too high for the cultivator he uses hoes, and only substitutes the plough for the hoe or cultivator when labour is scarce. Both plough and cultivator are kept to 2 in. in depth in order to avoid destroying roots.

A judicious pruning of the roots by the plough is of great value, if done at the proper time; for as the roots do not naturally branch, but grow straight out to great distances, pruning the roots induces branching at the severed ends and a further production of roots from the bulb.

A planter, for whose judgment I have the greatest respect, writes as follows: "I do not think that ploughing close to the banana and cutting through the roots does any harm. On the contrary, I am certain it does good, principally, I think, because the cutting gives fresh impetus to the roots, and this activity increases the growth of the plant. Take, say, potatoes or turnips, which are usually grown in drills 27 in. wide; so long as a horse hoe can work in these rows, it is good cultivation to keep working,

even to the damage of some of the leaves. Every time it is put through, all the roots crossing the drills must be cut, yet you see the greatest improvement in the growth of these plants."

The following experiment, made at a banana plot in Hope Gardens, throws light on the subject of the formation of new roots induced by cutting them back. In planting the plots, holes 3 ft. wide and 2 ft. deep were dug, the soil was returned to the holes and the suckers planted therein. The surrounding soil was ploughed and cross-ploughed after the plants began to grow. The soil is deep, rich, black, and rather heavy.

On November 19 a trench 1 ft. wide and $2\frac{1}{2}$ ft. deep was dug half-way round a one-year-old banana stool at a distance of 3 ft. from the stem that was about to fruit, and the soil returned. In doing this, the thick, fleshy roots, some of them 5 ft. to 6 ft. long, were severed. No roots were found below 6 in. from the surface. Ten days later the soil between the first trench and 8 in. from the stem was removed to the depth of 2 ft. 6 in. and returned, cutting off all the roots with the spade to within 8 in. of the stem. It was noticed when doing this that the roots that were cut off at 3 ft. from the stem had thrown out numerous fibrous roots down their entire length. A month later, on December 30, the soil was opened up from 3 ft. inwards in order to ascertain the effect of pruning the roots. New roots were seen to have grown out 3 ft. from the stem to a depth of 2 ft. from the surface. These roots were carefully followed back to the stem. Some proved to be new roots direct from the stem, whilst others had grown out from around the cut ends of the original roots, one root giving rise to five or six vigorous feeders. Some of the cut roots did not grow at all, but remained just as they were, except that they died back two or three inches; this was more noticeable near the surface, where they would come under the influence of dry weather. Some deeper ones had, however, rotted back a few inches, due, perhaps, to the ragged cut by the spade or to the root

itself being injured at its junction with the stem by the pull of the cut. The roots on the undisturbed side of the plant simply lengthened out a little and remained near the surface, 5 in. being the lowest depth at which roots were found. The plant did not show any ill effects from the disturbance of its roots on one side. It is evident that the rather drastic pruning enormously and very quickly increased the root system, and thereby greatly multiplied the power of the plant to absorb food material.

But ploughing, so as cut the roots close to the stem, should not be allowed when it is possible that the embryo bunch is being formed, for the cutting off of the food supply even for a short time, and even though much increased later, might come just when food material is most important in determining the size of the bunch. Further experiments are necessary, and probably it will be found that ploughing close to the stem may be done at the end of three months from planting, but not later. After that time, ploughing should be kept gradually further and further from the plant as the roots grow out, and be discontinued in the sixth month. The cultivator may be used continuously, if the earth mulch is employed.

Where ploughing is not the practice, the fork is used to great advantage when the young suckers are two months old. Where the rains are constant and the soil heavy, the cutlass is the best tool in weeding. The hoe, the assam fork, and the cultivator are tools used under different conditions. The disc harrow is an admirable instrument, and should be in constant use so long as the soil is sufficiently dry. If the ordinary plough forms a pan, a subsoil plough is used occasionally to secure good drainage.

CHAPTER VI

PRUNING AND TREATMENT OF SUCKERS. REASONS FOR PRUNING. METHOD. CHOOSING AND TIMING. PRUNING LEAVES

PRUNING AND TREATMENT OF SUCKERS

Reasons for Pruning.—Pruning away such suckers as are not intended to yield fruit is a most important operation. It should be done when the sucker is not more than one or two feet high. The larger the sucker grows, the more food material it abstracts from the parent bulb, and the more its young roots interfere with the root system of the plant, in both ways injuring the future bunch.

It has been suggested that the plan of constantly pruning the banana, in order to suit the market, must do serious injury to the plant. But a little consideration will show that this idea is erroneous. Plants of the type of the banana throw out numerous suckers, and also produce fruit. Thus reproduction is provided for in two ways—by vegetative multiplication and by fruit. If the vegetative energy is prevented from dissipating itself in suckers, there is all the more of that energy to be expended on producing new leaves for the plant itself. New leaves mean more food accumulated in the storehouse—the bulb—and available at the proper time for the production of an increased number of hands to the bunch. The suckers are rivals and competitors of the mother plant in getting food material from the soil. They do not help the mother plant, but are partly fed by it, and partly steal its nourishment in the soil. The more suckers there are in existence

the smaller will be the number of hands in the bunch for the mother plant, and the longer it will take for the suckers to fruit.

Method.—Care should be taken when cutting away the suckers to apply the cutlass, so that it does not point towards the plant, otherwise it is very easy to injure it. If the sucker is not cut away quite down to the white, hard part, it will soon spring again, and therefore time and labour are saved by doing it thoroughly at first.

Choosing and Timing.—Suckers shoot from the newly planted bulb from eyes all round, and sometimes from the centre. Some planters cut away the central sucker; others leave it, as it gives a fair bunch if the bulb is vigorous. On the south side, in irrigated land, two or three suckers may be left at equal distances round the bulb. It is well to take those that start from eyes placed low down, so that the roots have a good hold on the ground. One sucker takes the lead, as a rule, and becomes the plant, fruiting in ten to fourteen months; another comes in as a second sucker, giving a finer bunch four or five months later. Occasionally all the suckers will bear at the same time, when the bunches will not be so fine. It is the practice with some planters on the north side, after planting in March and April for fruit in February or March, to prune off all suckers till June, then to leave one just coming out of the ground which will fruit in the following April; in October another is left on the opposite side of the stem, and in February another which will fruit in fifteen or sixteen months. On the south side two suckers would be left instead of one in June, October, and February.

Plants vary, according to soil, situation, tillage, &c., in the time they take to produce fruit; the usual time is ten months to shoot (from time of planting), but often longer, and two and a half to four months more to ripen. Ratoons (*i.e.* suckers which take the place of the parent plant after fruiting) usually bear in fifteen to seventeen months. Judging from experience of his own estate, the

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planter may by careful pruning, if the rains are seasonable, so regulate his banana walk, when once established, that a large proportion of the crop shall come in during the months of high prices, from March to June.

In reckoning the time it takes suckers to fruit, plant suckers and ratoon suckers must be distinguished. When the bulb is planted, it grows into a plant sucker, and in the lowlands of Jamaica fruit may be ready to cut from it in twelve months, or even less, from time of planting, although unfavourable conditions, such as a poor sucker, drought, wind damage, may prolong the time; but, generally speaking, a plant sucker produces fruit fit for harvesting in twelve months from planting. It is quite different in speaking of ratoon suckers; first ratoons may take fifteen or sixteen months, or more, to mature fruit, but the older the banana and the thicker the shade, the longer the ratoons take to come into bearing. There is no discrepancy here, but the age of the plant sucker is not added to the twelve months. As a matter of fact, a plant sucker really takes longer to bear than a ratoon sucker, if the time is reckoned from the date of removing from the mother plant, but there is a period of rest after removal, a check to development, and new roots and new leaves have to be formed.

The whole subject is so important that no excuse need be offered for dwelling on it at considerable length, and adding observations by H. Q. Levy from the *Journal of the Jamaica Agricultural Society* (xvi. 305, 1912):

“I offer advice on this part of banana cultivation with a certain amount of diffidence, for so much depends on the size of sucker to be pruned, and its situation to other suckers, that it is hardly possible to lay down any hard-and-fast rule. There is no part of banana cultivation that needs as much individual attention, supervision, and judgment as the pruning. The retaining of wrong suckers may mean the loss of hundreds of pounds to the large cultivator. If the planter is fortunate in growing a fairly even field of plants, then all is plain sailing, as one size

of follower * may be left throughout the field, but otherwise, then each sucker must be treated on its own merits.

“I have observed more mistakes in pruning, entailing more or less loss to the owner, than I care to recollect : some from ignorance, but more often from greed. It is hardly possible to grow more than 450 stems per acre and get your followers *right*. Yet some persons try to get as many as 600 to 700. These speculators usually wind up by marketing not more than 200, and most of these in the bad months. It is quite possible to grow 700 suckers to the acre, but the followers and fruit take so long to mature, that not more than the above amount can be cut in one year after the *plant* crop is harvested. If the suckers be correctly spaced, and the land fairly fertile, 300 *payables* per acre may be considered a probable return, and no cultivator should attempt to produce more.

“The object in suckering is not only to obtain size of bunch, but primarily to meet the months of highest prices. A ten-hand bunch marketed in October fetches only 1s., one containing seven hands sold in April or May realizes the same price, and sometimes more to the grower, with lower cost of marketing and less chance of rejection ; therefore size of bunch is of secondary consideration. When a cultivator learns to prune correctly, then he can turn his attention to produce ‘straight’ bunches.

“The consumer abroad wants bananas during the spring months, and wants them badly, but what is more important, he is then not so particular as to quality, but in the later part of the year when his own fruits are in season, he gets fastidious, and will purchase only the best, and not much of that either. The fruit companies are there to supply the consumers’ wants, and they of necessity, so long as fruit is plentiful, select only good fruit ; it is, therefore, good policy from all standpoints to prune so as to market the bulk of your crops as near the month of March, April, May, and June as possible.

* “Follower,” a sucker left at the root of the parent plant to produce the succeeding crop.

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"It is somewhat difficult to explain on paper in a manner so that the beginner may grasp the details, the essential operation of pruning, but I will see what can be done by introducing dates. There exists a diversity of opinion as to the correct time and manner of pruning ; still there are certain tried and proved systems which, if followed, will be found fairly correct. But at the same time I must state that it is a known fact that even on the same property different fields require larger and smaller peepers* to be left according to the exposure or conformity of the land ; this therefore calls for individual experiment. It is well to remember this, as a mistake once made need not be repeated.

"I will deal with *Plants* first, and I will suppose that the cultivator is planting in a new field so as to reap his crop in the spring months of 1913. If the seed suckers have been planted, say any time between October 1911 and March 1912, and the weather conditions and soil fertility have been at all favourable, the *plant suckers* should have attained their full size by the end of October 1912. From the time of planting to August all followers should have been removed from the root of the parent plant. After August I would not advise any suckering until October 1, when a peeper 4 to 6 in. high should be left on each sucker if planted 14 by 14 ft., making two to each stool ; if 11 by 11 ft., only a single peeper would be retained. In the higher mountains and cold valleys I advise leaving a peeper 12 in. high at this time. Any backward sucker whose growth indicates lateness for spring prices should have a correspondingly large peeper or sword sucker left, if such be present. The parent plant will represent your spring crop for 1913, and the peeper the 1914 crop, these latter taking eighteen to twenty-one months from peeper to crop.

"On *Ratoons*, peepers, instead of being selected in

* "Peeper," a small pointed sucker, of about 4 to 12 in. high, starting below the level of the ground and sprouting through the earth, developing later into a "sword-sucker."

October, must be left from June to July, as they take from twenty-one to twenty-five months to mature a crop, and if the field be a closely planted one, even longer ; in fact it would be hard to tell the age of a sword sucker or peeper in such fields. On the plains, if ratoons are well grown, August peepers are safe, whereas in the colder altitudes of the interior regions May peepers one foot high are sometimes found to just answer.

“As I explained before, each planter at the start must experiment for himself, but after having once hit on the correct time to leave peepers, do not neglect even for a week to prune out those followers not wanted, as it is very difficult to tell the exact age of a sucker after it has passed the peeper stage.

“It is better to prune for an early crop rather than a late one, for if even 25 per cent. come too early, you can pick, choose, and refuse your followers ; whereas if an equal quantity happen to be late, the peepers in nine cases out of ten will also be late in starting from the bulb and showing themselves above ground. If you should be unfortunate in getting two *successive* late crops, it is extremely difficult, even for an expert, to bring back your field into correct fruiting.

“Do not make the mistake of leaving more suckers than I have advised, because they look stout and pretty. The earlier you remove the superfluous ones, the less temptation and heartache you will have. Too many suckers rob the parent plant, and later retard the maturing of the crop.

“*Never leave a peeper on a stump,** except where absolutely necessary, or a water sucker will result, producing for certain either a six or seven hand bunch. I have seen fertile land growing banana suckers that were strong and the picture of health, but the fruit from which graded nearly all sixes and sevens. The cause could easily be

* “Stump,” the remaining portion of plant after a bunch has been harvested, and the top containing the leaves and upper part of the trunk cut off.

traced to leaving most of the peepers on the stump instead of on the maiden sucker followers, as the operation of suckering was just proceeding, and the same system had been practised to produce the crop in sight."

PRUNING LEAVES

As the first leaves decay, they hang down all round, protecting the stem from the full glare of the sun. If they are cut away, the sheathing leaf stalks, which form the outside of the trunk, dry up and do not perform their proper functions. It is well to leave them, even in the shade of a banana walk, unless it happens that the plants are clustered closely together, when too much shade causes the stem to lengthen out and become weak and brittle. In such a case some of the dead hanging leaves may be pruned away. The hanging dead leaves must not be allowed to trail on the ground, as they encourage the production of roots coming to the surface, which are killed in dry weather, unless green mulching is practised. Some planters prune away even some of the living green leaves, but this cannot be recommended, as it interferes with the food supply. If, however, a leaf is seen to be growing through a bunch, and as it would, if left, cause some deformity or discoloration of the fruit, it is carefully removed from its position with the pruning tool. This tool is a semicircular instrument mounted on a long handle, with the convex side uppermost.

CHAPTER VII

HARVESTING AND REPLANTING

HARVESTING

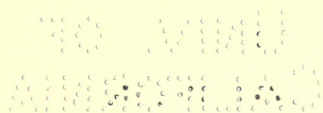
WHEN the bunch is to be cut, the stem is partly cut through 5 or 6 ft. from the ground, and the bunch, with the whole top of the plant, topples slowly over. Care is taken that it does not fall against and injure any other plant.

The usual custom is to cut fruit by the hundred stems, each cutter by himself, without help, cutting the fruit with a cutlass and catching it. This is, perhaps, a doubtful practice, as owing to want of method cutters running through the walks miss or roughly cut much of the fruit. A better plan is to employ a cutter and a helper who work together. The cutters with their helpers, twelve or fourteen in number, work in line, each cutter having three rows assigned him, or in close planting only two rows.

On some estates particular care is taken in harvesting ; one man with his pruning tool cuts and manipulates the fall of the head, while another catches the bunch and, when the stalk is cut, hands it to one of the women who are employed to carry it to a particular spot. This is necessary when we remember that a bunch weighs from 80 to 100 lbs. Here a bookkeeper enters it in his book under its proper denomination as a bunch, or one of eight, seven, or six hands ; or he may reject it as unmarketable for any one of several reasons—it is not “ full ” enough or too “ full,” the fingers are too small, there are not enough fingers on the lowest hand, badly shaped, straggly fruit, rat-eaten or otherwise damaged. Several bookkeepers on a large estate will thus be entering the bunches, while the



FIG. 7. CUTTING DOWN BANANAS
From a photograph by Mr. J. Minor Keith



owner or the manager, riding from one to the other, controls the number cut for delivery that night or in the early morning at the wharf. The bunches are wrapped in trash and handed up by two men to another in a wagon, who packs them in carefully so that there shall be no bruising. Wrapping is not necessary when the station or wharf is near at hand. It is singularly picturesque to ride through the shady rows of bananas, with here and there, all round, majestic heads falling and figures moving swiftly at their work, to note the quick movements of the men with keen upward glances, the stately walk of the women with a bunch balanced on their heads, all accompanied by the noise of the large leaves in their descent, the cries of the men, and the peculiar call for the women when they are wanted.

When the fruit is "caught" it is simply severed with a cutlass and removed. As soon after as possible men are sent into the fields to chop up both stem and leaves, leaving a stump of the cut stem of 3 to 4 ft. on the root, which benefits the suckers by the moisture it contains. If cut down to the root, undoubtedly the suckers would suffer. The stump withers, and can be pulled out and cut up later. When fresh cut, a man can easily chop 100 stems a day. The chopped-up stems are spread over the land, which can then be ploughed without obstruction, while they help to manure it.

The Baraton.—Instead of leaving the stump to wither, it is sometimes dug out by a special tool, described by Dr. James Neish * as follows :

"The *baraton* is a digging tool used in Nicaragua and other States of Central America in the cultivation of bananas. It is specially employed in the Central American countries for digging out and separating from the living stool the dead portion of the underground stem of a banana plant which has borne its fruit. This portion of the plant when allowed to remain in the soil hinders the growth of the parent stool by preventing it from throwing

* *Journ. Jam. Agric. Soc.*, v. 195 (1901).

out additional roots. It is claimed by cultivators of the banana in Central America that by the use of this implement or tool stronger plants can be grown, which are more firmly rooted and fixed in the soil, and are thereby better able to withstand and resist the force of strong winds. The plants so treated are also held to be more vigorous and to produce superior bunches of fruit.

“The name *baraton* (plural, *baratones*) is Spanish, and signifies a long lever. In Central America this implement is often termed a *macana*, which is a Mexican Indian term denoting a wooden weapon made use of in war by the Indians. In shape and appearance the tool resembles somewhat a long-handled spade, but the blade, instead of being flat, as in the spade, is made in the form of a vertical section of a cylinder, being curved or hollowed laterally. Its form thus adapts it to the circular contour of the stem, and it is forced into the soil pretty close to the decaying stem, and the adjacent earth is loosened by moving the long handle as a lever. It is then withdrawn and applied to the stem in a similar manner on the opposite side. Finally the mass of dead and decaying stem is removed by using the implement in front as if it were a spade. The soil is then filled in.

“The steel part of the implement is about $5\frac{1}{2}$ in. wide ; its height or depth is about 19 in., and the handle is very long in order to be used as a lever.”

REPLANTING

It is considered advisable to replant a banana walk after an interval which varies from three to six years. A certain proportion is replanted each year, so that every year some planting is going on. Advantage should be taken of this interval to increase the humus in the land. This can be very well managed by sowing some leguminous crop (such as Bengal beans, Jerusalem beans, velvet beans, or bonavist beans) in the field that is to be thrown up. If the land can be ploughed, two furrows may be run up



FIG. 8. CUTTING DOWN BANANAS
From a photograph by Mr. J. Minor Keith



the rows and the beans sown in them ; if the land is unsuitable for the plough, make holes with the hoe for the seed four feet apart. The leguminous climbers will in two months' time be climbing all over the old suckers. Cattle may now be turned in to feed down the dense vegetation. It may be considered advisable to plant another crop of beans and to have these fed down before it is time to prepare the land for planting again. In this way humus and manure have been added to the land, there has been feeding for cattle of better quality than if the fields had been abandoned to bush, and troublesome weeds have not been able to get hold of the land. Some planters have tried planting between the rows of first ratoons, as it is easier to regulate plants and first ratoons for the American market than later ratoons.

The question of replanting must be decided from various considerations : the field may be getting out of shape from the various ways in which the suckers have sprung from the parent plant, making it difficult to cultivate ; the bulbs may have got too high above ground, inviting destruction from high winds, and danger from dry weather ; the soil may require rest or a more thorough ploughing than can be given while stems are growing ; and the commercial question of paying better to plant for the American market.

CHAPTER VIII

BANANAS AS NURSE-PLANTS AND AS A CATCH-CROP

MANY crop-plants require to be shaded from the sun and protected from drying winds in the early stages of their existence, and for this purpose various "nurse-plants" are recommended. Many plants also take several years before they yield a crop, and it is important from the financial point of view that quick-yielding intermediate crops be grown between the permanent plants which will give an annual return while expenditure is going on without any return from the permanent plants; some of such intermediate "catch-crop plants" are also excellent nurse-plants.

Bananas are an ideal nurse-plant in the tropics. The ample leaves give good shade and protection from wind, and they can be so trimmed, if necessary, as to give just the amount of shade required. A dwarf variety or a very tall one can be chosen as seems best. The roots scarcely branch, they are not aggressive in the search for food, and therefore are not liable to interfere with the roots of plants near which they are growing; moreover, they do not exhaust the soil, rendering it unfit for the development of other plants in it. Bananas are readily propagated by the suckers, and can be easily and quickly raised in large numbers. When planted in favourable situations, they grow without requiring much attention, though any care and cultivation bestowed upon them give good results in fruit, and indirectly benefit the main crop.

Although easily blown over by high winds from an unusual quarter, they adapt themselves in a wonderful manner, by putting out strong anchoring roots, to resist a considerable force of wind if blowing fairly steady from one quarter.

The fruit is produced in about fifteen months, and yields an abundant supply of food. It is very remunerative, if there is a market for it, and, at any rate, can be utilized for the estate labourers.

Coco-nuts.—Although coco-nut palms do not need nurse-plants, it is desirable that the long period of about seven years before they yield a crop should not be wholly unremunerative for the waiting planter, and that some paying catch-crop should be grown. If there are estate labourers to be fed, it is often essential to have a supply of food ready to hand. It may even be necessary to attract labour by providing the supply, even if nothing is actually charged for it. If there is a market for the fruit, bananas will give a handsome profit, and it will not be necessary to live on capital while waiting for the coco-nut crop. If coco-nuts are planted at a distance of 30 ft. by 30 ft., a banana plant may be put in between each pair of coco-nut palms and one in the centre between every four palms. They may be removed at the end of six or seven years.

Cacao.—Cacao requires nurse-plants to shade it in the young state and to protect it from drying winds, and nothing is better for the purpose than the banana. They should be planted and allowed a start before the cacao is put out. Stakes or pegs should mark where the cacao plants are to go, and the bananas planted in the rows, one between each cacao stake, so as not to interfere with the ploughing, before and after the cacao is put out. The bananas may be kept growing for about five years, and then thinned out very gradually so as not to expose the young plants of cacao suddenly to the sun's heat.

If high winds blow down some of the bananas, it may

happen that some will fall against the cacao trees and injure them, but the chances are against more than a small percentage being injured in this way.

Rubber, Coffee, &c.—Bananas may also be used as nurse-plants for rubber, coffee, &c., and similar considerations apply to these plants.

CHAPTER IX

FINANCIAL CONSIDERATIONS AND PROSPECTS FOR BEGINNERS. COST OF CULTIVATION AND RECEIPTS. PROSPECTS FOR THOSE STARTING CULTIVATION

COST OF CULTIVATION AND RECEIPTS

IN considering the cost of preparing land and of cultivation afterwards, certain expenditure—for instance, that on buildings, roads, fences, tramlines—may well be entered as charges to be spread over a certain number of years.

In the irrigated district of St. Catherine, Jamaica, a fair amount that should be allowed for preparation of land and cultivation until the bananas begin to bear, is £15 an acre, and the annual expenditure afterwards would be £10 an acre.

The yield ought to be at the rate of 225 to 230 payable * bunches per acre, and taking the contract price all the year round at £8 15s. per 100, the receipts would average £20 an acre.

Whether the same price is paid for bananas throughout the year, or whether it varies as it does for the American market, the total annual receipts for a number of years average double the amount of the expenditure.

In the banana districts on the north side of Jamaica,

* "Payable bunches" or "payables" mean nine hands and over; eight hands bring only three-fourths the price of nine hands, seven hands one-half, six hands one-fourth. These are calculated into "payable bunches"—for instance, 400 eight hands mean 300 "straights" or nine hands, 500 seven hands mean 250 "payables," 100 six hands mean 25 "payables."

taking the average of the whole run of estates from Port Antonio westwards to Rio Bueno, the cost per acre to bring an estate into bearing would be about £10, and the maintenance afterwards £7 10s. The yield may be put down at 175 to 180 payable bunches per acre.

The cost of cultivation per acre differs, of course, in every locality. Much higher wages can be, and are, paid for banana work near a shipping port or the railway. At a distance of, say, ten to twenty-five miles from either, where road-transport is so heavy and costly as to render it impossible to ship fruit except for a few months in the year, wages are, and must be, lower.

I have been favoured by a banana planter with the following abstract of accounts for one year. It refers to an estate of 200 acres in an irrigated district on the south side of Jamaica.

Total Expenditure . . . £2038 14s. 4½d.

Bunches	Eights	Sevens	Sixes	Total cut	Payable
24,356	16,016	12,778	4468	57,618	43,827

Average of payables out of total cut—76 per cent.

RECEIPTS

	£	s.	d.
Bananas	3589	13	5
Suckers	35	15	5
Miscellaneous	10	1	10½
Total	3635	10	8½

The following figures derived from a banana plantation situated in a non-irrigated district on the north side will be useful by way of comparison. The soil is loose and gravelly without clay, rain 150 in. Thirty-one acres were planted to produce a crop the following year. There were besides 135 acres yielding fruit, of which fifty acres were plants, and eighty-five ratoons.

Total Expenditure £1250

COST OF CULTIVATION AND RECEIPTS 53

Payable bunches amounted to 40,916, or 303 to the acre. The receipts were £458 from miscellaneous sources, coco-nuts, cacao, and £2210 15s. 3d. from bananas.

The following is an example of the expenditure and receipts on a portion of woodland fifty acres on a pen, which has been utilized for cultivating bananas.

The operations were commenced in October 1899, and the expenditure to December 1901 amounted to £1312, which includes interest at 6 per cent., barracks of six rooms, purchase of suckers, and cutting down forest land.

The receipts month by month were as follows :

1900						£	s.	d.
December	.	.	.	.	.	2	19	1
1901								
January	.	.	.	.	.	7	17	11
February	.	.	.	.	.	31	19	9
March	.	.	.	.	.	154	4	11
April	.	.	.	.	.	526	2	7
May	.	.	.	.	.	425	15	6
June	.	.	.	.	.	367	5	0
July	.	.	.	.	.	185	12	6
August	.	.	.	.	.	97	0	3
September	.	.	.	.	.	84	9	11
October	.	.	.	.	.	128	18	11
November	.	.	.	.	.	75	0	0
December	.	.	.	.	.	68	0	0
Total						2155	6	4

A word of caution is necessary in considering the receipts. Every one who has had experience of growing bananas knows how a sudden "blow" may level hundreds of acres of stems, and this may happen just when the bunches are ready for the harvest, and a year's work and expenditure are lost beyond redemption. The planter should therefore insure himself in some way so as not to be left stranded without money to carry on cultivation for another year.

In the general review of banana cultivation in other lands, various estimates are given of expenditure, which may be compared with those stated for Jamaica.

PROSPECTS FOR THOSE STARTING CULTIVATION

A writer in the *Times* a few years ago gave such excellent and wise advice to those thinking of going to Jamaica to plant bananas, that it is well worth reproduction here for the consideration of emigrants to any tropical country: "Banana growing is undoubtedly a very risky business. Its profits are great when realized, but a violent north wind, such as occasionally blows in Jamaica, may destroy the whole growth of a year in a single night. There is no guarding against these 'blows' as they are called, and no anticipating them. The planter must take his chance. The wind bloweth when and where it listeth, and it may ruin one planter's crop, and leave that of another unscathed. On the other hand the profits, when realized, are very great. Good agricultural land may be bought in Jamaica for from £5 to £10 an acre. For agricultural purposes the very best land rarely sells for £20. The future of the fruit trade is now assured, so far as the opening of a new market in Europe can assure it. This being so, the question will naturally be asked, can a young man of energy who commands a moderate capital, say from £500 to £2000, and is prepared to work hard, be recommended to go to Jamaica and embark his capital in tropical agriculture? There is only one answer to be given to this question, and it cannot be too widely known. No man should dream of engaging in agriculture in Jamaica on his own account without having first studied the situation carefully and cautiously on the spot. The climate may not suit him, the nature of the occupation may not suit him, in a word he may not for one reason or another be the right man to succeed. That he must determine for himself. Jamaica is no El Dorado, it is no place where a man can plant his capital in the ground and then sit down and wait for it to grow. Tropical agriculture is not a trade to be learnt in a day. It requires an apprenticeship like any other, and the best thing for a young man to do who thinks it may suit him, is to seek a subordinate

situation on some plantation for a time, and judge for himself how he likes the life and what he thinks of the prospects. Such situations are not difficult to obtain by those who go the right way to work, and a young man who takes one will very soon find out, or be told, whether he is likely to succeed. But I repeat with all the emphasis I can command that a young man who goes to Jamaica without experience and without training, possibly with little aptitude for hard work of any kind, and with none at all for hard work in the tropics, and expects to turn his capital into a fortune in a few years, had much better stay at home."

CHAPTER X

BANANA SOILS IN JAMAICA

THE following facts about banana soils in Jamaica may be helpful in showing how much can be done to improve and make productive even the most unpromising soils.

“In the early stages* of the industry in Jamaica ‘banana land’ was accepted to mean a soil in which without drainage, without tillage, and by a superficial process of clearing and, perhaps, burning, before the suckers were planted a good yield of commercial fruit was obtainable by the grace of Nature alone. Where fine alluvial deposit has been reinforced with the humus from a prolonged growth of forest or ruinate, and the district is a seasonable one, such old-fashioned ‘banana land’ is still to be found in Jamaica, but in rapidly decreasing extent. To a superficial observer of the initial conditions of the banana industry in Jamaica it might have seemed as though the banana was pre-eminently a product of virgin soils, and that as the first flush of the stored fertility of these soils became exhausted the growing of bananas would be difficult, if not impossible. Under these conditions the vast area of virgin soil on the Spanish Main would appear certain to displace the resources of so small and long settled an island as Jamaica for the profitable cultivation of the banana.

“Jamaica, however, in starting the banana industry had behind its resources the traditions and enterprise of many generations of English and Scottish agriculturists of

* *Bull. Dept. of Agric.*, New Series, i. 221 (1911).

the first rank who had created the lucrative sugar industry in the old days, and had battled with adversity when that industry was so seriously prejudiced by the operation of the Continental bounties on beet sugar. To planters of this grade, the cultivation of the banana soon became more than the voluntary bounty of Nature in smiling on the favourable conditions of soil and of climate.

“To men who had grown cane on the dry plains of St. Catherine by the use of irrigation, it was but a natural sequence to attempt the cultivation of the banana under the same conditions. Now every drop of water available from the resources of the Rio Cobre System is being utilized in this manner, and bananas are being produced on 10,000 acres of land that was formerly of nominal value for grazing purposes. These soils would be classed as natural banana soils, and the only condition required to make them productive is irrigation. Had they been in Portland and St. Mary these soils would have been found capable of growing magnificent crops of bananas with very little modification of the forces of Nature.

“It was ascertained very early in the history of the industry in Jamaica that the banana could not stand stagnation of soil. It was assumed that this crop could not be grown on the rich clays of the St. Mary hills, and that the banana land in that entire parish was restricted to the alluvial bottoms and glades of rich, friable soil. During the past decade the pioneers in St. Mary have demonstrated that from the very summits of the hills to the deepest glades, from the undulating folds of the upland hills to the flat clays of the coastal region, there is hardly an acre of land that cannot be made to produce good bananas. A bird's-eye view of this parish may now be likened to a vast expanse of bananas, and as new roads are opened out into the outlying areas, an ever-increasing spread of this cultivation is steadily taking place. The chief cultural problems in St. Mary have been drainage,

ANALYSES OF BANANA SOILS PHYSICAL ANALYSES

No.	Description	Parish	Gravel	Sand	Fine Sand	Silt	Fine Silt	Clay	Agri- cultural Clay	Combined Water and Organic Matter	Re- tentive Power for Water
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	First-class high land .	Portland	0.41	5.46	23.89	23.65	13.77	2.72	16.49	25.10	44
2	Alluvial—good average .	"	3.23	7.97	44.38	30.20	7.05	0.54	7.59	6.63	45
3	Alluvial—good average .	St. Mary	1.33	1.29	30.71	13.25	33.99	11.06	45.05	8.37	53
4	Alluvial—stiff soil .	"	0.26	0.94	22.07	22.87	24.11	17.45	41.56	12.30	63
5	Calcareous soil .	"	0.31	0.89	22.74	67.39	2.53	Traces	2.53	6.14	58
6	Upland heavy soil .	"	0.26	0.94	22.07	22.87	24.11	17.45	41.56	12.30	63
7	Lowland—light alluvial	"	0.22	1.38	23.83	63.79	0.48	Traces	0.48	10.33	61
8	Irrigable alluvial—good average	St. Catherine	2.75	11.27	40.79	39.34	3.06	0.49	3.55	2.30	46
9	Red soil .	St. Ann	2.74	4.05	30.62	55.59	0.81	0.83	1.64	5.36	56
10	Alluvial soil .	St. Thomas	1.39	4.74	26.91	51.46	7.24	1.81	9.05	6.45	55
11	Alluvial soil—irrigable .	Vere	1.12	0.50	32.32	54.72	4.57	1.41	5.98	5.36	54
12	Old cane land .	St. James	1.52	0.68	11.72	72.98	1.81	1.63	3.44	9.66	62

ANALYSES OF BANANA SOILS

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No.	Insoluble Matter	Potash	Lime	Phosphoric Acid	Carbonate of Lime	Combined Water and Organic Matter	Humus	Nitrogen	Moisture	Available Potash	Available Phosphoric Acid
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	27.87	0.6796	1.379	2.760	0.600	25.10	9.86	0.704	24.86	0.057	0.0908
2	67.59	0.572	1.881	0.161	0.221	6.63	1.75	0.118	4.90	0.021	0.0422
3	68.07	0.9249	1.62	0.138	0.506	7.93	3.58	0.196	7.62	0.027	0.0096
4	54.22	0.2907	0.2437	0.0254	0.120	12.30	3.15	0.211	9.66	0.015	0.0329
5	43.14	0.607	18.402	0.120	31.629	17.65	2.36	0.198	6.54	0.006	0.0238
6	54.22	0.291	0.244	0.025	0.120	12.30	3.15	0.211	9.66	0.033	0.015
7	64.03	0.960	1.191	0.085	0.316	10.19	1.14	0.089	11.51	0.004	0.013
8	78.54	0.392	1.022	0.218	0.174	5.52	3.61	0.162	2.35	0.053	0.064
9	18.17	0.172	0.254	0.393	0.454	25.34	3.62	0.130	5.66	0.011	0.007
10	62.44	0.853	2.560	0.246	1.560	—	1.81	0.172	—	0.013	0.044
11	68.93	0.573	0.951	0.168	0.296	9.95	2.81	0.155	5.66	0.021	0.044
12	57.04	0.321	1.294	0.229	1.748	13.91	4.53	0.310	10.69	0.007	0.0285

both on the flat and on hilly lands, and a lack of humus on the old lands which in some cases had grown canes continually for over a century before they were planted up in bananas. These problems have been tackled by the planters in that parish with the most remarkable success, and the results of contour drains on steep hill-sides and of deep mains in the flat clay lands have shown that the heavy soils, when properly treated, are the best and most productive banana soils in the parish, while the growing of green crops and implemental tillage have restored worn soils to a pitch of full productivity.

“In the parish of Trelawny are found some of the richest soils in the island, but owing to the droughts that periodically occur the bananas were found to be apt to dry out. The Trelawny sugar planters have long led the way in the art of mulching, and by the application of the grass mulch on a liberal scale on these old sugar lands it has been demonstrated that profitable crops of bananas can be grown despite the most adverse conditions of rainfall. Even on the ‘red dirt’ derived from the limestone it has been shown that good crops of bananas can be grown in such a parish as St. Ann by the judicious use of the mulch.

“It is gradually dawning on our agriculturists that there are few cultivable soils in Jamaica below 1500 ft. in elevation where bananas cannot be grown by suitable methods of cultivation, drainage, mulching or irrigation where that is available.

“In 1901, the writer commenced a study of the banana soils of the island, the results of which appeared in the *Bulletin* from time to time, but as the years roll by, so the range becomes wider and wider, until to-day it is hardly possible to classify any particular grades or types of soil as ‘banana land.’ If the working basis of the latest and most progressive cultivators be regarded, it would appear that a ‘banana soil’ and a ‘cultivated soil’ will soon be synonymous in Jamaica. It would appear highly probable that many soils that have been tested under

inadequate conditions of drainage or of tillage may in the near future yield success to planters with more enterprise and knowledge than their predecessors who have tried and failed.

“For present purposes, a few soils typical of different classes and types of land on which bananas are grown with success have been selected and their composition and analysis set forth [on pp. 58 and 59].

OBSERVATIONS

“No. 1 represents a very rich deposit overlying the limestone on an estate in Portland where magnificent bananas were grown year after year. This might be taken as an ideal banana soil—rich in humus and available plant food and of a rather retentive but not impervious consistency.

“No. 2 is an average alluvial soil in Portland that has been long under cultivation and is on the limit of productivity as first-class banana land. This is a light soil from which the humus is rapidly abstracted under cultivation with a high rainfall. The present standard of humus is low and the nitrogen also below par. Chemical fertilizers when tried on this soil were inoperative. The provision of vegetable matter to restore the humus is clearly the problem to be faced in this case.

“No. 3 is a representative of a non-calcareous alluvial soil in St. Mary where excellent bananas are and have been grown for many years by good tillage and green dressings.

“No. 4 is a type of the heavy banana soils of this parish. Forking and deep drainage have worked wonders on this material.

“No. 5 is a representative of the alluvial deposits rich in calcareous matter that are largely found in St. Mary. This soil failed to respond to the most generous applications of chemical manures, but at once yielded a full grade of fruit when subjected to thorough implemental tillage and top dressings of cowpeas.

“No. 6. This is a sample of the hill-side clays in St. Mary that were formerly regarded as hopeless for the growing of bananas. Forking and drainage enabled excellent results to be obtained, whereas fertilizers were inoperative in the absence of such special aids to cultivation.

“No. 7. This is a light, alluvial soil from St. Mary that had probably been worked for a century as cane land before being put into bananas. In its present state it is rather below par in fertility. The humus, nitrogen and potash are all low. Trials with fertilizers proved disappointing. Measures for increasing the humus appear to be all that is necessary for enabling such land to yield full returns of bananas.

“No. 8. This is an average sample of the irrigable alluvial soils in St. Catherine as served by the Rio Cobre Irrigation System. The mechanical composition is an ideal one for bananas under irrigation, and the employment of implemental tillage. During ages of dry conditions these soils were reinforced by the growth of the guango and other leguminous trees. They are of a full standard of fertility, and on some of these soils over 90 per cent. of straight bunches are obtained over a large acreage. The ‘Galls’ that occur here and there in some fields are generally small areas of coarser sands devoid of humus. Experiment has shown that fertilizers have no beneficial effect upon these abnormal spots. The reserves of fertility in the St. Catherine soils are very great, and if due care be taken to avoid stagnation from the excessive application of water, these soils should hold their own for many years to come as first-class banana lands.

“No. 9. This represents a typical red soil from the limestone as existing in the uplands of St. Ann. Such a soil has been found to be generally lacking in humus and to be subject to drying out during a period of drought.

“Fertilizers were found quite inoperative, but recent experience on a fairly large scale has indicated that if liberally mulched with grass and other vegetable refuse

fine crops of bananas can be grown on such soils. It would appear that the practice of mulching would enable a large extension of banana cultivation on the red soils to be successfully brought about. It is noticeable that although derived from the limestone, the red soil has a very moderate content of this material now remaining. The process of weathering frequently removes almost the last traces of lime from these soils, and in some cases the addition of lime has a marked effect on its productive powers.

“No. 10. This is a sample of the soil from that magnificent alluvial flat at the eastern end of St. Thomas that was formerly of enormous value for the growing of cane, and is now in bananas. These soils are excellent banana lands, and magnificent crops are obtainable if the exposed situation of the lands does not result in the loss of the crop by breeze as has too frequently been the case during the past ten years. It would appear to the writer that the wisest policy would be to utilize the bananas for establishing cocoa and coco-nuts on these lands, and eventually to abandon the banana in favour of these crops that are not so subject to damage from wind. The fertility of these soils and their adaptability to cultivation are even greater than the bare figures of the analysis would indicate, while the rainfall is liberal and the climate hot and humid and favourable to the growing of large crops.

“No. 11. This is a soil that has been found to grow bananas well in Vere. The recent developments in the modernization of the sugar industry in that parish have, however, encouraged the planters to grow more canes, and this would appear to be a more suitable and satisfactory crop for this, the most fertile alluvial tract in the island.

“No. 12. This is a good specimen of some of the abandoned cane lands of St. James, which are rich but rather retentive soils requiring only thorough tillage and ample drainage to yield fine crops of bananas. There are great possibilities for the extension of the banana as a

cultivated crop of this parish, but in many cases special methods and treatment of the soil are required to ensure success. The 'Sugar-cane climate,' associated with a dry spring, is a difficulty which may require in some districts special measures for securing a good tilth and mulching to secure a good return of early fruit when the prices rule high."

CHAPTER XI

HUMUS. FARMYARD MANURE. LIME

It is evident that, in every single particular, experiments should be made by the planter in order to determine what method is best for the special soil and climate where the cultivation is carried on, and in no respect is this more necessary than with manures. The old theory, founded on Liebig's teaching, that, having analysed the plant and the soil, it was a simple matter of calculation to find out what fertilizers to apply, is now discredited. It is very difficult to estimate correctly what proportion of any particular element in the soil is actually "available" for the use of plants; and again, it does not follow that all the substances found in analysing a plant are necessary to its well-being. The physical and mechanical condition of soils appears to be more important than the chemical composition.

According to the *Bulletin* of the Bureau of Agricultural Intelligence and of Plant Diseases for December 1912, modern research into the physical properties of the soil in different parts of the world leads to the conclusion that in studying soil nutrients, the crude form of chemical and mechanical analysis of air-dry soil does not give results that are truly representative of the nutritive potentialities of the soil investigated. For instance, liquids of different composition can be obtained from the same soil by pressure, washing (trituration), and leaching by rain; and it is held that in nature two soils of similar chemical composition may give rise to entirely different plant conditions

as a result of continual alterations in the concentration of the soil waters.*

HUMUS

For bananas it is important that there should be decayed vegetable matter, "humus," in the soil. According to Voelcker, "the principal effects of humus on the soil are of a physical character, and it exercises particular benefit through its power of retaining moisture. Humus, however, has a distinct chemical action, in that it forms combinations with iron, calcium, and ammonia. It thus becomes one of the principal sources of supply of the nitrogenous food of plants, and a soil rich in humus is one rich in nitrogen."

FARMYARD MANURE

Farmyard manure is to a large extent composed of humus, and contains all the constituents required by crops; but the physical condition of the soil is also improved by its use, inasmuch as the land is kept porous, and air is allowed free access. It may be spread fresh on the banana fields and ploughed in at any time. The great difficulty is to get enough of it, but whatever there is should be applied as soon as the plants are put in, or, generally speaking, at the earliest stage possible in the life-history of the plant or ratoon. Green manuring should be used as a substitute, if farmyard is not available. (*See paragraphs on Mulching, p. 33.*)

LIME

The use of lime is of the greatest importance, as it increases fertility, chiefly by improving the physical texture of the soil.

It is natural to suppose that any soil derived from limestone must have abundance of lime in it. But natural agencies, chiefly the carbonic acid and water in the soil,

* *Agric. News*, xii. 104 (1913).

remove the lime. Professor A. D. Hall states that lime is disappearing from the unmanured plots at Rothamsted under arable cultivation at an approximate rate of 1000 lbs. per acre per annum—a rate which is increased by the use of manures like sulphate of ammonia, but diminished by the use of nitrate of soda and of dung. He says that “failing the renewal of the custom of chalking or liming, the continuous removal of calcium carbonate thus indicated must eventually result in the deterioration of the land to the level of that which has never been chalked at all, and even a state of sterility will ensue if much use is made of acid artificial manures.” Dr. Phipson has shown that, on a sugar estate in British Guiana, in fields which have been under cultivation from ten to fifteen years, the percentage of lime in the soil was 0·44 to 0·64, but the percentage in fields cultivated for sixty years had fallen considerably, amounting only to 0·11 to 0·40.

The action of lime on clay is to cause the minute particles to become grouped together to form larger grains with wider interstices, so that both air and water can percolate more freely. Lime binds sands together somewhat, so that in both cases it improves the tilth and the capillarity of the soil. However, there is a danger of rendering sandy soils too light and open.

Lime is also of much value when applied after ploughing into the soil the cut stems and leaves of the banana, or the green manuring, as it helps to decompose the organic matter, or humus, and thus encourages nitrification and makes the nitrogen and other constituents of the humus available to the crop. If, therefore, there is only a small quantity of humus in the soil, and it is not renewed, lime does more harm than good, as the humus is speedily used up, and the soil becomes sterile.

It improves sour land by neutralizing the acid materials. By combining with certain constituents of the soil, it sets free potash and other useful food material, and so, although not exactly a manure in itself, the effect on the land is that of a manure.

Quicklime is suitable for use on stiff clays and on rich soils, while marl and chalk are better for light soils deficient in organic matter. The quicklime should be slacked before spreading. One ton per acre every four or five years has been recommended, and better results may be obtained by applying 4 or 5 cwt. every year.

CHAPTER XII

FERTILIZERS

"It is generally recognized that the great practical problem confronting the soil chemist is the proper use of soil amendments or fertilizers. The farmers of the United States now spend annually for fertilizers upwards of \$100,000,000. It is estimated by various authorities that a large fraction, perhaps as much as three-fourths, of the material represented by this expenditure is misapplied for lack of intelligent direction. Yet all of this enormous mass of fertilizers can be used to advantage." *

Experiments have been carried on in various places with fertilizers for bananas, and perhaps the most useful account of these that has been published is of some undertaken by the Government of Queensland. In Fiji also manurial experiments with China bananas have been carried on from 1907. The aim of the experiments has been to test the effects of manures in general, and to see if land on which bananas have been cultivated for some years can be made to give payable returns by the use of manures. The results, according to Mr. C. H. Knowles, Superintendent of Agriculture,† tend to show that the application of nitrogenous manure and superphosphate is beneficial, and that potash appears to increase the total weight of the crop, but has little or no effect on the number of hands of the bunches.

With reference to the application of fertilizers in Queens-

* "The Soil Solution." By F. K. Cameron, in charge Physical and Chemical Investigations, Bureau of Soils, U.S. Department of Agriculture. 1911.

† Report on Agriculture for the year 1910, Fiji.

land, Mr. A. J. Boyd* informs us that in May 1909 Mr. A. W. Benson, then Instructor in Fruit Culture in Queensland, was deputed by the Minister for Agriculture, Queensland, to proceed to Buderim Mountain, and select suitable sites on which bananas had been grown, for experimental work in manuring. He selected two plots of land, both of which were so exhausted that to attempt to grow bananas on them in that condition would have been to court failure. After consultation with the Agricultural Chemist, Mr. J. C. Brünnich, the composition of a complete manure was decided on. The ground having been thoroughly prepared, the planting of bananas was done in September 1909; and the whole work was carried on by the growers under the personal supervision of Messrs. Benson and Brünnich. Mr. Benson was appointed Director of Agriculture in Tasmania, but the experiments were continued by Mr. Brünnich, who gives the following Fourth Progress Report and table† on page 73, as the result of the first harvest of fruit:

“The first harvest of fruit from the Banana Manuring Experiment Blocks has just been completed and the results are quite satisfactory. The experiments show that exhausted banana lands, as long as the soil is in good physical condition and contains a fair amount of humus, may be made to yield fair profitable crops with thorough cultivation and heavy manuring.

“Our manurial basis, the minimum quantity of fertilizing materials necessary which have to be applied annually, is—

160 lbs. of Potash,
80 lbs. of Phosphoric Acid,
40 lbs. of Nitrogen per acre,

when the stools are planted 12 ft. apart, giving 302 stools per acre. With ordinary artificial fertilizer this amount works out to an application of $3\frac{1}{2}$ lbs. of manure, at a cost of about $3\frac{1}{2}d.$ per stool.

* *Queensland Agric. Journ.*, xxix. 48 (1912).

† *Ibid.* xxvi. 317 (1911).

“On very poor, exhausted lands, this quantity of manure has to be applied *twice* a year, about March and October, so that at the end of the first harvest, in March, when the plants are eighteen months old, the plantation will have just received its fourth application of manure, and the second harvest would be obtained with five dressings of manure, at a total cost of about 1s. 6d. per stool, and with a probable harvest of about ten dozen the first crop and twenty-five dozen the second harvest, under favourable weather conditions.

“With regard to the actual artificial fertilizer to be applied, the experiments so far teach us that phosphoric acid should be applied in the form of superphosphate, nitrogen in the form of dried blood or of nitrate nitrogen (nitrate of soda or nitrate of lime). The stools which received nitrates gave by far the best-cooking and heaviest fruit. Ammonium sulphate does not appear to do well as a source of nitrogen.”

The following * is the Fifth Progress Report by Mr. J. C. Brünnich : “Last year, on account of long dry spells, was exceptionally trying to our banana crops, making the crop particularly late ; still the results of the experimental plots on Buderim Mountain are highly satisfactory, and prove clearly the great advantages of thorough and deep cultivation, combined with a liberal application of artificial fertilizers.

“The harvest from the first series of experiments, representing the second year’s crop, as the plots were planted in October 1909, is quite up to expectation, as seen from the results tabulated on pp. 76–78. The table gives both the number of dozens of bananas and the number of bunches (in brackets) for each plot, and also calculated yield per acre.

“On Mr. Foote’s plot the yield agrees, with almost mathematical accuracy, with the quantities of artificial fertilizers ; and the high yields of experimental plots B, F, and I, on which double quantities were applied, with

* *Queensland Agric. Journ.*, xxviii. 349 (1912).

54, 50, and 43 hundred dozens of bananas per acre, are easily picked out, and form a striking contrast with the result of the unmanured plot D, on which the stools are practically dying out. On Mr. Guy's plots, first series, the results are not so striking, and in most cases the bunches were very much later, so that, in order to get a fair comparison of the second year's harvest, which, as a rule, was taken in our experiments up to December in each year, we estimated the crop up to March (figures on the table in italics). The poorer results of Mr. Guy's plots of the first series are partly due to heavy washaways in the earlier stages of growth.

"So far no definite conclusions can be drawn from the first series of experiments with regard to the advantages of either superphosphate (P) or Thomas' Phosphate (Pt), but the superiority of dried blood (Nb) and of nitrate of lime (Nn) as a source of nitrogen over ammonium sulphate (Na) is quite apparent.

"With regard to the second series of experiments, which were planted in September 1910, the lateness of the crop, due to a rather dry season, is particularly noticeable on Mr. Foote's block, and only on plots L, M, and N, on which, prior to the planting of bananas, a very heavy crop of pigeon-peas was grown and ploughed under, the majority of the bunches was harvested by the end of December. The crop itself is not quite up to the results of the first year's crop of the first series. The stools, however, look particularly well, and the growth of the second suckers is quite phenomenal, resembling the healthy vigorous growth of bananas on virgin scrub land, so that the second year's harvest should be a very heavy one. On Mr. Guy's block, second series, the bunches matured earlier all round, and the yield was quite as good as that of the first crop of the first series, experimental plots 12 and 14, with the double amount of fertilizers, giving again the best results.

"On all the experimental plots green manures were grown between the bananas, and the crop of small

FERTILIZERS

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Plot No. 1 Plot No. 2
(J. Foote, Esq.) (W. H. Guy, Esq.)

No. of Experiment	Manures applied per acre	Total cost of Manures in pence per stool	Number of Bananas per stool	Dozens of Bananas per bunch	Number of first bunches in Experimental Blocks	Number of Suckers	Number of Bananas	Dozens per bunch	Number of first bunches	Number of Suckers
1	KPN	6 $\frac{1}{4}$	96	9	32	73	18	6	7	55
2	2(KPN) } Blood	12 $\frac{1}{2}$	120	10	36	83	19	6 $\frac{1}{2}$	7	66
3	$\frac{1}{2}$ (KPN) }	3 $\frac{1}{8}$	76	8 $\frac{1}{2}$	27	70 (poor)	11	4	6	47
4	Nil	—	49	5 $\frac{1}{2}$	27	48 (v. poor)	15	6	6	44
5	$\frac{1}{2}$ (KPN) } Nitrate	3 $\frac{1}{2}$	88	8	33	57 (poor)	55	7	17	56
6	2(KPN) }	14	101	8 $\frac{1}{2}$	33	75	86	7 $\frac{3}{4}$	26	57
7	KPN }	7 $\frac{1}{8}$	94	8 $\frac{1}{2}$	34	72	55	6 $\frac{1}{2}$	20	54
8	KPN } Ammon.	6 $\frac{1}{4}$	104	9 $\frac{1}{4}$	33	71	29	5 $\frac{3}{4}$	12	61
9	2(KPN) }	12 $\frac{7}{8}$	106	9 $\frac{1}{2}$	34	70	67	7 $\frac{1}{2}$	21	53
10	KPN }	5 $\frac{7}{8}$	94	8 $\frac{1}{4}$	34	66	47	6 $\frac{1}{2}$	17	44
Number of Stools for each Experiment, 36							Number of Stools for each Experiment, 26			

Note.—K = 160 lbs. K₂O = 320 lbs. Sulphate of Potash.

P = 80 lbs. P₂O₅ = 470 lbs. Superphosphate or Thomas' Phosphate.

N = 40 lbs. N, as 286 lbs. Dried Blood, or 250 lbs. Nitrate of Soda, or 200 lbs. Ammonium Sulphate.

2 (KPN) means double quantities. $\frac{1}{2}$ (KPN) means half quantities.

Mauritius bean and cowpea on Mr. Foote's block were very heavy, covering the ground well. These crops are being cut down, as the season of many thunderstorms is pretty well over. the stools mulched with the green

ANALYSIS OF BANANA PLANTS GROWN ON BUDERIM MOUNTAIN, QUEENSLAND

BANANA PLANTS : ASH						
	Lady's Finger		Cavendish		Sugar	
	—	Pure Ash	—	Pure Ash	—	Pure Ash
Weight of green plants	118 lbs.	Per cent.	52 lbs.	Per cent.	62 lbs.	Per cent.
Moisture per cent.	87.69		90.00		85.54	
Dry Material "	12.31		10.00		14.46	
Pure Ash "	1.14		1.31		1.14	
containing—						
Silica, SiO ₂ . . . . .	.270	23.68	.201	15.34	.245	21.49
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃ .	.015	1.32	.023	1.77	.021	1.88
Manganese Oxide, MnO . . . . .	.026	2.32	.023	1.77	.021	1.88
Lime, CaO . . . . .	.219	19.24	.278	21.33	.151	13.25
Magnesia, MgO . . . . .	.064	5.66	.092	7.02	.100	8.77
Soda, Na ₂ O . . . . .	.050	4.44	.021	1.60	.022	2.00
Potash, K ₂ O . . . . .	.378	33.17	.480	36.64	.437	38.83
Sulphuric Acid, SO ₃ . . . . .	.007	.66	.018	1.38	.020	1.75
Phosphoric Acid, P ₂ O ₅ . . . . .	.030	2.65	.019	1.46	.040	3.52
Chlorine, Cl . . . . .	.121	10.62	.199	15.20	.103	9.10
Nitrogen, N . . . . .	.107		.133		.136	

LBS. OF PLANT-FOOD MATERIAL					
—	In each Plant	In Plants per acre	In each Plant	In Plants per acre	In Plants per acre
Lime, CaO . . . . .	.258	154.8	.144	86.4	55.8
Magnesia, MgO . . . . .	.075	45.0	.048	28.8	37.2
Potash, K ₂ O . . . . .	.446	267.6	.250	150.0	163.2
Phosphoric Acid, P ₂ O ₅035	21.0	.010	6.0	15.0
Nitrogen, N126	75.6	.069	41.4	50.4

FERTILIZERS

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BANANA FRUITS : ASH				LBS. OF PLANT-FOOD MATERIAL			
	Lady's Finger		Cavendish				Sugar
	—	Pure Ash	—	Pure Ash	In each Bunch	In Bunches per acre	
Weight of bunch	22 lbs.	Per cent.	39 lbs.	Per cent.			Per cent.
Approximate number of bunches per acre	432		555		16 lbs.		460
Moisture per cent.	75.9		79.8		72.75		27.25
Dry Material "	24.1		20.2		27.25		92
Pure Ash "	1.18		.94				
containing—							
Silica, SiO ₂ . . . . .	.082	6.960	.059	6.225	.063		6.923
Iron and Alumina, Fe ₂ O ₃ Al ₂ O ₃ . . . . .	.033	2.835	.010	1.112	.037		4.061
Manganese Oxide, MnO . . . . .	.001	.119	.002	.200	.001		.115
Lime, CaO . . . . .	.039	3.324	.020	2.125	.018		2.016
Magnesia, MgO . . . . .	.071	5.995	.056	5.925	.056		6.091
Soda, Na ₂ O . . . . .	.033	2.815	.018	1.880	.023		2.506
Potash, K ₂ O . . . . .	.734	62.350	.605	64.250	.555		60.625
Sulphuric Acid, SO ₃ . . . . .	.017	1.445	.013	1.329	.015		1.659
Phosphoric Acid, P ₂ O ₅ . . . . .	.083	7.010	.058	6.150	.071		7.748
Chlorine, Cl . . . . .	.108	9.175	.130	13.900	.098		10.728
Nitrogen, N . . . . .	.212		.202		.304		

LBS. OF PLANT-FOOD MATERIAL			
In each Bunch	In Bunches per acre	In each Bunch	In Bunches per acre
Lime, CaO . . . . .	.0086	.0097	.0029
Magnesia, MgO . . . . .	.0155	.0217	.0089
Potash, K ₂ O . . . . .	.1615	.2360	.0888
Phosphoric Acid, P ₂ O ₅ . . . . .	.0182	.0226	.0113
Nitrogen, N . . . . .	.0466	.0787	.0486
			1.36
			4.10
			40.80
			5.21
			22.38

CROP RESULTS OF BANANA MANURING EXPERIMENTS ON BUDERIM MOUNTAIN, QUEENSLAND.

YIELD IN DOZENS OF BANANAS (NUMBER OF BUNCHES IN BRACKETS).

Experiment	Per Experiment			Per Acre	
	1910	1911	1911 (estimated)	1911	1911 (estimated)
EXPERIMENTAL PLOTS OF W. H. GUY, ESQ.—FIRST SERIES (PLANTED OCTOBER 1909)					
1. KPNb		43 (7)	119½ (15)	202½ (37)	464 (75)
2. 2(KPNb)		45 (7)	179½ (18)	274½ (36)	485 (75)
3. ½(KPNb)		24½ (6)	54½ (7)	117½ (24)	264 (65)
4. O		35 (6)	Nil	10 (4)	378 (65)
5. ½(KPtNn)		127 (17)	154 (15)	199 (25)	1370 (183)
6. 2(KPtNn)		197½ (26)	332½ (29)	423½ (43)	2152 (280)
7. KPNn		127½ (20)	227 (21)	327 (37)	1375 (216)
8. KPNa		68 (12)	177½ (17)	315½ (35)	733 (129)
9. 2(KPNa)		157½ (21)	177½ (25)	258½ (37)	1699 (226)
10. KPNa		110 (17)	274½ (25)	305½ (32)	1187 (183)
					2184 (399)
					2961 (388)
					1268 (259)
					108 (43)
					2147 (270)
					4558 (464)
					3527 (399)
					3403 (378)
					2788 (399)
					3295 (345)
SECOND SERIES (PLANTED SEPTEMBER 1910)					
11. 2(KPNb)		Poor crop	155 (22)	179 (26)	1931 (280)
12. 2(KPNn)		{ of Narico	174 (23)	189 (25)	2039 (270)
13. 2(KPNn) salt		{ Beans	151 (23)	172 (27)	1855 (291)

14. 2(KPNb) salt	.	.	176½ (25)	201½ (29)	—	2174 (313)
15. O	.	.	112½ (19)	135½ (25)	—	1462 (270)
15a. Shrl. 5(¾K3½P1½N)	.	.	170 (23)	170 (23)	—	1834 (248)
16. O Lime	.	.	64 (12)	104 (24)	—	1122 (259)
17. 2(KPNn) Lime	.	.	123 (18)	151 (24)	—	1629 (259)
18. 2(KPNb) Lime	.	.	132½ (20)	171½ (26)	—	1850 (280)
19. 2(KPNn) Lime Salt	.	.	86 (14)	130 (22)	—	1402 (237)
20. 2(KPNb) Lime Salt	.	.	97½ (15)	132½ (21)	—	1429 (226)

EXPERIMENTAL PLOTS OF J. FOOTE, ESQ.—FIRST SERIES (PLANTED OCTOBER 1909)

A. KPNb	.	.	287 (33)	489 (44)	2281 (262)	3886 (350)
B. 2(KPNb)	.	.	359½ (36)	682½ (57)	2857 (286)	5424 (453)
C. ½(KPNb)	.	.	229½ (32)	261½ (26)	1824 (254)	2078 (207)
D. O	.	.	146 (25)	89 (11)	1160 (199)	707 (87)
E. ½(KPtNn)	.	.	267½ (34)	345 (35)	2126 (270)	2742 (278)
F. 2(KPtNn)	.	.	302 (35)	631½ (56)	2400 (278)	5018 (445)
G. KPtNn	.	.	283 (35)	422 (42)	2249 (278)	3354 (334)
H. KPNa	.	.	312½ (35)	427 (41)	2848 (278)	3398 (326)
I. 2(KPNa)	.	.	319½ (35)	544½ (49)	2539 (278)	4328 (390)
K. KPtNa	.	.	281 (34)	466½ (50)	2233 (270)	3708 (397)

SECOND SERIES (PLANTED SEPTEMBER 1910)

L. KPNb Salt Lime	.	.	135 (20)	155 (25)	—	1232 (199)
M. 2(KPNb) Lime	.	.	155 (23)	183 (28)	—	1454 (223)
N. KPNb	.	.	161½ (21)	183½ (25)	—	1458 (199)

CROP RESULTS OF BANANA MANURING EXPERIMENTS ON BUDERIM MOUNTAIN,
QUEENSLAND—*continued*

Experiment	Per Experiment			Per Acre	
	1910	1911	1911 (estimated)	1911	1911 (estimated)
SECOND SERIES (PLANTED SEPTEMBER 1910)— <i>continued</i>					
O. O	.	.	.	5 (1)	80 (13)
P. O Lime	96 (19)
Q. KPNn Lime	.	.	.	5½ (1)	140 (27)
R. 2(KPNn) Lime	.	.	.	5 (1)	152 (29)
S. 2(KPNn) Salt Lime	.	.	.	11½ (2)	133½ (25)
T. 2(KPNn)	.	.	.	—	132 (25)
U. 2 (KPNn) salt	.	.	.	—	177½ (27)
					636 (103)
					763 (151)
					1113 (215)
					1208 (230)
					1061 (199)
					1049 (199)
					1411 (215)

Note.—K = 160 lbs. K₂O, as 320 lbs. Potassium Sulphate per acre
 P = 80 lbs. P₂O₅, as 470 lbs. Superphosphate per acre.
 Nb = 40 lbs. N, as 290 lbs. Dried Blood per acre.
 Nn = 40 lbs. N, as 290 lbs. Nitrate of Lime per acre.
 Na = 40 lbs. N, as 200 lbs. Ammonium Sulphate per acre.
 P = 80 lbs. P₂O₅, as 470 lbs. Superphosphate per acre.

2(KPN) means double quantities.

½(KPN) means half quantities.

All manures applied twice a year.

Figures in italics include the crop up to March,

manure, and the ground between the rows to be well scuffled and cultivated afterwards.

“The early maturing of bunches in the rows, on which a heavy crop of pigeon-pea was grown and ploughed in, has already been noticed, and this must be due to the large amount of humus enabling the ground to hold the moisture better.

“The leguminous crops on Mr. Guy’s blocks are not doing so well, and this is undoubtedly due to a greater want of lime in this soil. This fact was borne out by the analysis of soils taken from the limed and unlimed portion of the second series, when we found that the limed soil contained only 0·22 per cent. total and 0·054 per cent. available (citric and soluble) lime, whereas the unlimed soil gave a little higher results ; but both soils had a strong acid reaction.

“When planting green manure crops between the rows of bananas, it is very important to keep the stools themselves clear, as in dry seasons the green crop would rob the ground of too much moisture. It is advisable to have the ground covered during the season of heavy rainfalls ; the crop should afterwards be cut down, and the soil cultivated during the dry months.

“It is quite evident that only soils with a fairly large amount of humus will grow bananas successfully, and the humus can easily be supplied by suitable green-manure crops.

“Our experiments should show how long bananas can be grown profitably on old exhausted banana lands by the aid of heavy applications of artificial fertilizers, costing, with two dressings with the double standard amounts, about 1s. 3d. per stool annually. The advantages of utilizing old lands are many, and should amply pay for the heavy cost of fertilizers.”

The following translation of an article on manures for the banana by M. A. Couturier of Paris is by Dr. James Neish,* who has added notes in brackets :

* *Journ. Agric. Soc, Jamaica*, vii. 175 (1903).

“The banana requires a complete manure, bringing to the soil at the same time nitrogen, phosphoric acid, and *potash*, with predominance of the last-named element. We are happy to find ourselves on this point in perfect agreement with the views of M. Dugast on the one part, and on the other part with those of M. Teissonnier, Chief of the Agricultural Service of French Guinea, who has studied very closely on its own ground the manuring of the banana.

“Most frequently the dead leaves and stems of the banana are used as manure ; in these it is thought that the greater part of the elements removed from the soil are restored to it ; but the useful effect of this vegetable matter is very feeble, on account of the slowness of their decomposition, and it is preferable, according to the authoritative advice of Semler, to make composts of them in mixing them with ashes, lime, farmyard manure, &c., and to allow them to rot during a year—still it will be necessary to add potash and phosphoric acid in which they are deficient. The guanos, generally employed at the Azores and in the Canary Islands, the oil-cakes and the fish-manure employed in India, are equally insufficient, and ought also to be made complete by the addition of potassic and phosphated manures.

“Some excellent results have been obtained in Madeira, in a volcanic soil, poor in potash and in phosphoric acid, but rich in nitrogen and better provided with carbonate of lime than the greater part of tropical soils, by the application of a complete manure, testing :

Nitrogen	13 per cent.
Potash	20 „ „
Phosphoric acid . .	16 „ „

“This manure, which is a mixture of very concentrated and very soluble products, is applied in the proportion of 50 grammes per plant, equal to $1\frac{3}{4}$ oz., in a trench made about 18 in. around the stem. The application of

this manure is made twice a year, so that each plant receives in all 100 grammes of the mixture ($3\frac{1}{2}$ oz.).

“To us this quantity appears too little, also that it would be to the interest of the planter to strengthen still more the proportion of potash in the complete manure by giving the whole of the nitrogen under an organic form, as oil-cake, guanos, fish-manure, farmyard manure, composts, &c.

“We advise the trial of a manure testing

Potash	20 per cent.
Phosphoric acid	10 „ „

“This manure can be very easily prepared by mixing, for manuring a hectare planted with 1500 plants (equal to 600 plants per acre): 400 kilos of sulphate of potash, containing 50 per cent. of potash, and 600 kilos of mineral superphosphate, or the same quantity of basic slag, which would furnish at the same time lime and phosphoric acid.

“To reduce the expense of transport, there would be equally an advantage in giving the phosphoric acid in the form of superphosphate containing 45 per cent. of phosphoric acid ; there would then be required 240 kilogrammes per hectare.

“(These quantities, reduced to English weights and measures, would be as follows : 400 kilos of sulphate of potash per hectare are equal to 880 lbs., and this is equal to 344 lbs. per acre. Six hundred kilos of mineral superphosphate are equal to 1300 lbs. per hectare, and this is equal to 530 lbs. per acre ; and 240 kilos of the stronger superphosphate, generally known as Professor Wagner’s ‘double phosphate,’ are equal to 528 lbs. per hectare, represented by 211.2 lbs. per acre.)

“The mixture can be easily made without there being any fear of loss of fertilizing materials. It should be employed in the proportion of 400 or 600 grammes per plant, according as the preference may be given to the double superphosphate or to the common kind. (Equal to 14 oz., and to 1 lb. 5 oz., respectively.) Care must

be taken to place the manure in a trench made around the stem, avoiding placing it in direct contact with the latter, so as to prevent accidents.

“This manure costs at the maximum 200 francs per hectare, about $1\frac{1}{2}d.$ per plant, without counting the nitrogenous manures. It is a very small expense, which will be largely compensated by the regularity of and increased yield in the crops.”

The Director of Agriculture in Jamaica states in his Annual Report for 1909-10, with reference to that colony only, that “some recent experiments with manures have confirmed our former conclusions, that bananas do not require fertilizers, and that humus, lime, and drainage are the chief factors that are of practical importance to the cultivator of this crop in Jamaica. If it be remembered that the drain on an acre of land, by the removal of 300 stems of bananas, is less than that of the crops of wheat grown at Rothamsted for sixty years on the same soil without manure, it is not a matter for surprise that the banana should be so little responsive to chemical fertilizers.”

CHAPTER XIII

FUNGUS DISEASES

1. DISEASES OF THE BULB AND LEAVES

Panama and Costa Rica.—McKenny, in May 1910,* gave an account of a disease in Panama and Costa Rica. The disease was first noticed among the various plantations in Panama, in 1906, in fields five to six years old. From certain spots it spread all round, affecting at last a considerable area. The fields when ten years old were absolutely worthless. Thirty miles from this district the disease makes its appearance, but only sporadically. In Costa Rica it is serious in certain localities.

“Commonly the first external sign is a rapid yellowing and subsequent browning and wilting of one or more leaves. Sometimes there is a striking curvature and yellowing of the terminal part of the leaf blade while the remainder is still green. Eventually all the leaves die and fall back against the trunk, leaving a crop of suckers which in turn are killed and give place to still weaker shoots. The fruit of diseased shoots rarely matures, and even when mature is worthless, with blotched, somewhat shrivelled surface and dry, pithy interior. Shoots which develop after one or two suckers have died rarely reach the flowering stage; when they do, however, weak, distorted, worthless bunches are produced. On cutting the pseudo-stem [trunk] across and longitudinally many of the bundles are found to be of a yellow, reddish or reddish-purple colour, the colour deepening towards the root-stock. In the last stages the colour of the bundles may be almost black. While in

* *Science*, xxxi. 750.

recently affected plants the vessels of the upper part of the stalk and the leaves may be normal, those of the root-stock [bulb] are always coloured. . . . A nauseating odour is often given off when leaf stalks which have been diseased for some time are cut open, though there may be no sign of rotting in the trunk."

McKenny found both bacteria and fungus hyphæ in the gummy substance blocking cells and vessels of the xylem-portion of the vascular bundles, but did not determine the cause of the disease.

H. Levy described the disease in Costa Rica in 1910.* He points out what seems to be a characteristic of this particular disease, that the sheaths of the trunk of young plants split from the bulb upwards for a distance of one to two feet, sometimes right through to the heart, in which case the young embryo leaves push out through the aperture and develop. "With the older plants the first sign of infection is manifested in a different way: a fringe of yellow will appear on the lower leaves of the plant. . . . After a few days the entire lot of leaves turn yellow; at this stage it is often confounded with suckers suffering from drought or lack of drainage, but in a few days the disease puts on another symptom which is peculiar to it. All the leaves suddenly turn a brown colour and hang quite limply down the side of the sucker, the heart, leaf, and bunch, if young, turning black. . . . In a 'sick' bunch the tips of the fingers present a pinched-in appearance, something like dry-weather fruit, when it starts to ripen in the open. It will not do so evenly as a healthy bunch would, but one finger here and there all over the bunch, the yellow fingers showing up in contrast to the green ones. . . .

"The leaves have not such a crisp feel as those that are found on dry-weather bananas or from the natural shedding of the leaves, but a soft damp feel, which continues until all the moisture dries out; it is only a matter of time when the whole tree rots to the ground, giving off

* *Journ. Jam. Agric. Soc.*, xiv. 241.

a very offensive smell. At all stages of growth, if the bulb of an infected sucker be split open, the heart will be found rotten and composed of a putrid yellow mass ; further out the fibres will be found to be firmer, but still in a decomposing state and having a yellowish tinge, until the outer part is reached, and here will be found, say about one inch from the surface, a bright red streak flanked to the outside and inside by a brighter yellow than occurs on the other part of the cut surface ; the red streak follows all the passages to the roots and continues all along these to their extremities. All the roots will present a sickly appearance, some quite dead, others partly so, but none quite healthy. The smell given off by a diseased banana sucker is offensive and peculiar, and if once experienced cannot be mistaken."

Cuba.—Erwin Smith* reported that he had investigated a disease of bananas which occurs in Cuba, and from his material had isolated a species of *Fusarium* (*F. cubense*) which, when inoculated into the midrib, leaf-stalk, and trunk, gave a typical discoloration of the vascular bundles, and from these the fungus was again isolated. The experiments had to be discontinued before the bulb could be infected.

Trinidad.—The "Moko" is a variety of plantain which was at one time commonly grown in Trinidad as a shade plant for young cacao. About twenty years ago, this variety was almost extirpated by a disease which was not investigated until 1910, when J. B. Rorer, the Mycologist of the Department of Agriculture of Trinidad, commenced a careful study of it. At first he supposed it was the Panama disease, many of the symptoms being similar, but the longitudinal splitting of the leaf-sheaths forming the trunk, which is so characteristic of the Panama disease, does not occur, and the common banana or Gros Michel, which is so susceptible to the Panama disease, appears to be practically immune from the "Moko" disease. The results of Rorer's exhaustive study of this disease were

* *Science*, xxxi. 750.

published in April 1911 under the title, "A Bacterial Disease of Bananas and Plantains," in "Phytopathology," and reprinted by the Board of Agriculture of Trinidad. The disease is caused by a bacterium (*Bacillus musæ*). This organism was isolated from diseased plants, and used to infect other varieties and species of *Musa*. The red banana and the dwarf or China banana (*Musa Cavendishii*) succumbed to inoculation. The Manila hemp plant (*Musa textilis*) proved to be quite resistant, and although some of the inoculated plants of the common banana (Gros Michel) died, the progress of the disease was slow, some remained apparently quite healthy, and the fact that this variety has never been found to be naturally affected leads Rorer to believe that it is, as has been stated above, practically immune from this particular disease. This disease has been easily kept under control in Trinidad on several small plantings of plantains and bananas by sanitary measures alone. As soon as a diseased plant is noticed, it is dug up and burnt on the spot, and all tools and instruments used in the work are sterilized by fire. All suckers are examined before planting.

The symptoms of the disease, according to Rorer, are as follows: "The presence of the disease is as a rule first detected in the lower leaves. The leaf-blades droop a little more than usual and have a slightly yellowish tinge, symptoms very similar to those brought about by drought. Soon, however, the stalk of one of the leaves gives way just at the base of the leaf-blade, and all the other leaves quickly break down in a similar manner. Eventually the terminal leaf too bends over, and the plant dies and rots down to the ground.

"Transverse sections of the trunk show that practically all the vessels are discoloured, the colour ranging from pale yellow to dark brown or bluish black, and filled with bacteria. The discoloured bundles run back into the true stem and thence into the young suckers and buds. Sometimes in badly diseased plants the tissues of the leaf-stalks and stems are broken down completely, so that

fairly large bacterial cavities are formed. If transverse sections of leaf or stem are let stand for a short time, the cut surfaces soon become covered with bacterial drops which have been forced out from the ends of the bundles. If the sections, when freshly cut, are put in large covered dishes away from the air, pure cultures of the organism may be obtained directly from these drops. If the disease is not severe, or a plant does not become infected until it has just formed a bunch of fruit, it may remain perfectly healthy-looking, but many of the young fruits, or 'fingers,' do not properly mature: they remain small and eventually become black and rotten. In such cases it is found that there are some discoloured bundles filled with bacteria in the leaves, stem, fruit-stalk, or fruits. When diseased suckers are planted, the terminal leaf frequently turns black and dries up, so that the plant dies."

Rorer states that the true Panama disease also exists in Trinidad.

Surinam.—In April 1911 Essed published in the *Annals of Botany** an account of a so-called Panama disease which is virulent in Surinam, and described a fungus which he believes is the cause of the disease. The disease appeared on fields only one year old, and the loss amounted to 25 to 75 per cent. of the second and third crops. On some fields the entire crop was lost. It is only since extensive fields of the commercial banana (Jamaican banana, Gros Michel) have been planted that this disease has attracted attention. This banana appears to be most susceptible; the "Lady's Finger" banana, the common plantain, and the China banana are not subject to it.

The first symptoms of the disease in Surinam, according to Essed, are a withering of the margin of the leaves and a discoloration along the midrib; sometimes the youngest (unopened) leaf withers, the others remaining healthy; sometimes the older leaves wither before there is any arrest of growth in the youngest leaf. Then development ceases, the leaves droop, the plant looks water-starved,

* xxv. 343.

wrinkles appear in the sheath (trunk) and midrib of the leaves, which gradually dry up, and finally the trunk bends down along a line of least resistance. As soon as the disease becomes evident, the bulb when cut shows signs of putrefaction. Its whitish colour has turned yellowish with reddish-brown spots or streaks. The roots do not begin to decay before the tissue at their base is affected, proving that the germ does not enter by them. Essed has traced the starting-point of disintegration to an old wound-surface, and he says that there is "reason to assume that the fungus at the start behaves as a wound parasite or saprophyte, living at first on the exudation, and by degrees making its way up into the damaged vessels."

The disease is caused by a previously undescribed fungus, which the author proposes to call *Ustilaginoidella musæperda*.

The fungus at first attacks the fibro-vascular bundles, preventing the passage of water along the wood vessels, which explains the water-starved appearance of the plant, and then spreads outwards, forming numerous spores of more than one kind.

In the rhizome (bulb) of a diseased plant the fungus is found chiefly in the wood vessels and adjoining tissue; the vessels become discoloured and the sap is absorbed by the fungus in them. The first change in the parenchyma is an unusual cloudiness of the protoplasm, apparently caused by an enzyme secreted by the fungus; the brown discoloration and the slimy degeneration of the walls of the vessels must also be ascribed to an enzyme. Gradually the cell contents are absorbed and replaced by the cartilaginous sclerotium. Transverse sections of the leaf-blade show that the hyphæ in the vessels send out branches at right angles to the walls; these end in the intercellular spaces among the subepidermal cells and produce oblong or irregular sclerotia. In the sheath special sclerotia are formed in the star-shaped parenchyma cells: the hyphæ which enter these cells send branches into the rays,

where they form sclerotia which give rise to little spores.

In the leaf-blade the fertile hyphæ develop in or among the palisade parenchyma cells ; some of them reach the inner walls of the outermost parenchyma layer, forming sclerotia, which, after remaining dormant for a time, produce spores ; the spores may remain in the sclerotium, or the pressure of the surrounding tissues may force them into the cells above ; they become free after the leaf has decayed. The hyphæ may also penetrate into the sub-epidermal layers, filling the cells with sclerotia ; or they may emerge on the surface of the leaf as little brown gall-like swellings (*Mycocecidia*) ; sometimes they go back through the epidermis or through the stomata, or they ramify all over the surface of the leaf, producing numerous sickle-shaped conidia.

Essed found bacteria, but proved by inoculation of healthy plants that the fungus, and not the bacteria, was the cause of the disease as it occurs in Surinam. He was not successful in finding remedies to prevent the spreading of the disease. Plants once diseased, of course, cannot be cured, and therefore remedies must be limited to a prevention of spreading. Spraying with Bordeaux Mixture the plants all round an infected spot and burning infected plants is the natural suggestion to make as a beginning.

The United Fruit Company employ an expert agent to travel and collect every kind of disease-resistant commercial banana for their plantations in Jamaica and in continental America. They had great hopes at first of a variety which was called the "Congo" banana, and was reputed to have come originally from the West Coast of Africa. Although immune from disease, and planted to some extent as an experiment in Surinam in substitution of the Jamaican, the fruit has not found favour with the fruit merchants, as the fingers ripen irregularly and are apt to get broken at the neck and drop off before becoming fully ripe. (*See under Surinam in Chapter XXIX.*)

Surinam Elephantiasis Disease.—Besides the "Panama

Disease" another disease has long been known, though never widespread, in the banana fields of Surinam and Colombia; but it does not cause much apprehension among the planters.

The disease* shows as a swelling, sometimes enormous, of the base of the trunk, hence called "bigie footoe" or "elephantiasis." The oldest leaves then begin to wither, owing to rupture of the tissue close to the trunk; these leaves hang on during the winter, and do not look any different from the ordinary dead leaves; but careful examination shows a number of little galls (*Mycocecidia*) on the sheaths and leaf-stalks, some of them projecting through the epidermis. The end of the shoot may go on growing for some time after the outer leaves are dead, but the young leaves are always poorly developed and chlorotic. At this stage the upper part of the rhizome (bulb) can be broken off clean by a slight pull.

Sections in the rhizome show that the fungus attacks first the outer and upper part of the parenchyma. The sloughing of the lower leaves is probably due to tension caused by the enormous quantities of hyphæ making their way through the tissues to the outside of the leaf-sheaths; and probably also to a slow disintegration caused by enzymes secreted by the fungus. As the fungus extends horizontally just below the bases of the outermost leaves, it is probable that this is the region of infection; if it is only when the tissues at this point are young and thin that infection can take place, the slow spread of the disease receives a ready explanation.

Essed obtained from the diseased plants pure cultures of a fungus, and has named it *Ustilaginoidella ædipigera*.

The spread of the disease can be checked by spraying with Bordeaux Mixture.

The latest information on the subject of the principal disease in Surinam is given by Drost in *Bulletin* No. 26 of the Department of Agriculture, Surinam.† The author states that this disease is different from that prevalent in

* Essed in *Ann. Bot.*, xxv.

† *Agric. News*, xi. 142 (1912).

Panama and Costa Rica, though it has long been known as the Panama disease, and although it also attacks principally the Gros Michel variety. He bases this statement on a comparison of Levy's description of the true Panama disease with the symptoms of the Surinam form as observed by himself. He proposes the name "Surinam Panama Disease," to distinguish it from the form prevalent in Central America.

The principal symptoms of the Surinam disease are given as follows: (1) The occurrence of yellow spots on the leaves; this is best seen in young plants; it cannot be taken as a definite symptom, as it may be occasioned by other causes. (2) The sudden appearance of one or more incompletely developed leaves. (3) Longitudinal splitting of the external leaf-sheath. (4) In the most usual form plants of six months or older, which have been previously healthy, show a softening, ribbing, and folding of the heart-leaf, provided no fruit is present. The older leaves break off at the junction of the stalk and leaf-sheath, turn yellow, and die in a few days. The plants are quite dead a few weeks later. When fruit is present, the trunk remains with the bunch at the top, but the fruit is without value, as even when it is apparently ripe it has no taste. The root systems of diseased bananas do not appear to be less strong than those of healthy plants.

On cutting open a diseased bulb it is seen that the vascular bundles are discoloured brown, and that the discoloration extends into some of the bundles of the leaf-sheath as well as, in some cases, into certain of the vascular strands of the roots. The central portion of the bulb may commence to rot when the disease is in an advanced condition, but the outside remains firm for some time. The main differences between this description and that of Levy are that there are no external symptoms of disease in the roots, that the plants dry up and do not rot, and that there is no smell. The absence of rotting in the bulb is a particularly noticeable point of difference, except in the final stages of the disease.

Drost has shown by infection experiments that the Surinam Panama disease is due to a fungus named *Leptospora musæ*, which has *Cephalosporium* and *Fusarium* stages in its life-history. It can penetrate the root-hairs, and thence spread into the central bundle of the roots, whence it passes into the root-stock and ascends the vascular bundles of the leaf-sheaths. Usually, however, it attacks directly the bundles exposed at the place where the suckers have been cut from the mother plant, under the surface of the soil. The fungus is not as a rule found in the leaf-blade or in the fruit-stalk.

India.—A disease of bananas was reported in April 1911 by S. K. Basu * as occurring near Chinsurah, Bengal.

The variety of banana known as *Kanthali* suffered much, but the most profitable variety, known as *Martaman*, suffered most, so much so that this variety of banana has become practically extinct in these localities. The varieties known as *Champa* and *Kuncha* (the latter being used green as a vegetable) are free from all attack of this disease.

The chief symptoms of the disease are : (1) The turning yellow of some of the older though otherwise healthy leaves ; (2) the formation of one or more much reduced leaves at the crown ; (3) the gradual withering of the younger leaves ; and (4) finally the breaking down of the plant. The disease progresses so rapidly that in ten or fifteen days from the first appearance of it the plant is found dead.

By cutting a plant transversely near the base of the leaf-sheath, the disease becomes noticeable either as black, brown, or yellow spots, varying in size from that of a circle three or four inches across. In longitudinal sections these spots appear like streaks, which seem to pass from the roots upwards into the root-stock and the leaf-sheaths. In many places where a young plant is still attached to another plant the disease passes from the mother plant to the young offshoot directly through the point of contact.

* *Quarterly Journ. Dept. of Agric., Bengal*, iv. 196.

Microscopic examination of the sections of the root-stock and the leaf-sheath revealed the presence of hyaline or slightly coloured septate hyphæ in or about the fibro-vascular bundles. In some cases minute colourless, more or less oval-shaped spores of a fungus known as *Cephalosporium* have been noticed appearing in balls or clusters from short stalks or conidiophores within the vessels. In the course of a day the mycelium produced a new form of crescent-shaped spores of the fungus known as *Fusarium*, but no higher form of fructification than these two have been noticed.

Jamaica.—A disease of the leaves in Jamaica was reported by F. S. Earle in 1903.* The disease causes the browning of the vascular bundles in the veins and midrib of the leaf, followed by the blackening and eventual decay of the whole leaf and its stalk. The disease does not extend into other parts of the plant, but as new leaves open out they also become affected. The diseased plants are stunted and do not bear fruit. The disease appears to travel slowly, and to have been introduced into the small field by suckers from neglected patches in the neighbourhood; it did not spread later from the spot where it was first noticed into the district round. Earle obtained cultures of a bacterium from the diseased leaves which he sent to Erwin F. Smith, of the U.S.A. Department of Agriculture, Washington, who stated that he inoculated leaves of bananas in Washington with this material, but without result.

The mycelium † of *Marasmius semiustus* Berk. and Curt. penetrates the tissues of the trunk, and attacks the embryonic flowers and flower-stalk, as they grow up through the centre of the trunk. The fructifications (small toadstools) appear on the surface of the trunk; the colour is white, becoming a yellowish brown as they dry; the pileus is $\frac{1}{2}$ to 1 in. broad, attached to its stem eccentrically, at first convex, then flat; gills wide apart and as they

* *Journ. New York Bot. Gard.*, iv.

† *Journ. Linn. Soc.* x. 1869; *W. Ind. Bull.*, x. 244.

approach the stem connected by wrinkles ; stem $\frac{1}{2}$ – $\frac{3}{4}$ in. long, thin, compressed. It has been known in Jamaica and Trinidad for some years. A planter in Jamaica, who has had great experience, writes as follows : “ I am of opinion that this disease only makes its appearance upon young plants that are growing on very poor or water-logged land. I have seen it in my fields repeatedly, but it has no detrimental effect on healthy plants. The sucker that it makes its appearance on is generally a weak one, which in any case would not be kept to come to maturity. The disease seems harmless, as I find it plentiful in my banana walks upon such suckers as have suffered injury, but it does not attack the strong, healthy ones. Personally, I have no fear of its doing material damage.”

Outbreaks of the Surinam Panama disease * occurred in Jamaica in 1911, but the disease was promptly suppressed, and has not made its appearance since. In one case the plants, after being cut down, were chopped up and treated with heavy dressings of lime ; in another case the plants were destroyed by fire. According to the Infectious Diseases of Plants Law all bananas within a distance of twenty-two yards of any diseased plant must also be destroyed ; and the infected land must be surrounded by a fence sufficiently strong to prevent people passing through, and to keep out straying animals. All instruments used on the diseased plants are disinfected by fire, and no banana plants may be grown on the land for a certain time until there is no risk from resting spores which may infect the land.

Other diseases of the banana have been observed since January 1911 : one, a rot of the heart-leaves, was suppressed by cutting away the infected portion, and spraying with Bordeaux Mixture ; another, caused by a fungus attacking the roots and outer portion of the bulb, and carried by cutlass infection from plant to plant, was quickly put down ; a third, the “ banana spot disease,” spread so rapidly that very prompt measures had to be taken, and the plants were destroyed by fire. No botanical examina-

* *Ann. Rep. Dept., Agric., Jamaica, 1912.*

tion of these three diseases was made. A fourth disease, found in neglected cultivations and known locally as "saltpetre" and "black-head," has been determined by the Mycologist of Jamaica to be the well-known pineapple disease of the sugar-cane (*Thielaviopsis ethacetica*); but this disease is not considered dangerous, if remedial measures be promptly taken.

It is supposed that the Surinam Panama disease had been present in Jamaica for five years, and possibly for eight or ten years, and yet only 5 per cent. of the plants on the infected area were diseased. The inference drawn by the Director of Agriculture is that the conditions in Jamaica favour a strong constitution in the plants, making them almost immune from this disease.

Under the Infectious Diseases Law * no one is allowed to grow diseased bananas or other economic plants which may spread disease to his neighbours. Any person having reason to believe that disease exists in land neighbouring to his own, may notify the person in charge to carry out the treatment prescribed under the law; if no attention is paid to this, the matter is reported to an inspector. Inspectors may inspect plants suspected to be diseased, and are empowered to carry out the treatment prescribed at the cost of the owners; if it is impossible to cure the disease, the plants are to be cut down and burnt.

2. ROOT DESTRUCTION BY FUNGUS MYCELIA†

(1) *Stone Fungus*.—The soil of banana cultivations in Australia is occasionally found to be compacted in irregularly shaped masses that have an almost stone-like density. These masses are due to the mycelium of a fungus filling every interstice of that portion of soil, and enclosing root-fibres and other bodies. The outer surfaces of these masses are defined by a thin, dense, almost black layer, principally formed by iron that the organic matter present, in the

* *Journ. Jam. Agric. Soc.*, xv. 405 (1911).

† H. Tryon in *Queensland Agric. Journ.*, xxviii. 284 (1912).

form of this fungus matter, has caused to be segregated round it. When they involve the roots of growing plants, such as those of the banana, these succumb to their attacks, and the plants themselves fail to thrive. One of these stone-making fungi has been described, occurring in South Australia.*

When these masses are detected in the soil, they should be dug out and thrown upon a fire, so as to raise them to a high temperature. A solution of sulphate of iron applied to the soil in which they occur may destroy the fungus growth.

(2) Another fungus attacks the banana in Australia through its root system—a kind of toadstool, probably *Armillaria mellea*, that commonly occasions Tree Root Rot. In this case the plant ceases to thrive, the stems are short and slender, and the foliage yellowish and unhealthy-looking. On digging up the stool, white threads (strands of mycelia or rhizomorphs) are seen traversing it in all directions, and giving off a decided fungus odour. A section of the stool itself will discover these threads also occurring within the tissue of the older portions, small cavities now occurring, being white in consequence. These parts, too, are dead and of a brown colour, with numerous dark particles disseminated throughout them.

When this trouble occurs, the plant should be dug out and burnt, and the soil for a foot or two around removed and sterilized by heat, or receive a generous application of fresh lime that is to be dug well in.

As a rule this root-fungus only occurs where the bananas have been planted in newly felled land, and, originating in certain decaying roots that still lie in the soil, it passes to the root-stocks of its victims, being enabled to establish injurious relations with these when growth has been interfered with by dry weather or other physical causes. It commonly persists for a long time in a spot in which it has once manifested itself, attacking plant after plant, as

* McAlpine (D.) and Tipper (T. G. O.), "A New Australian Stone-making Fungus": *Trans. Roy. Soc. Victoria*, 166, 3 plates (1894).

healthy bananas have been substituted for unhealthy ones.

Some loss * is caused among banana plants in Fiji by a disease locally called the "banana disease." It shows its presence in the dwarfing of the plant and a rather sudden tapering off towards the crown, where the leaves are small and yellowish green. If the upper part of such a plant is cut open, the leaves which have not yet appeared above the plant will be found to be crumpled up, and will lengthen out considerably immediately on being released. There is doubt as to the exact nature of the disease, which has been in Fiji for eighteen years; and although plants have been imported from different parts of the world, they seem to be as subject to the attack as the local plants. On digging up a diseased plant, many of the roots will be found to be black and rotten; and on examining a little of the decomposed root under a microscope very many nematode worms are to be seen together with fungal hyphæ.

3. DISEASES OF THE FRUIT

RIPE ROT FUNGUS, FRUIT ANTHRACNOSE OR BLACKENING † (*Glæosporium musarum* Cke. and Mass.)

This disease chiefly affects ripe or ripening fruit, and its presence is marked by black blotches, which spread over the surface, causing rotting. It is due to the attacks of a fungus that occurs in the black areas in the form of a pinkish dust-like substance that is closely sprinkled over them. This matter is composed of the massed spores of the organism, that—adherent to one another—issue through point-like orifices in the skin, and are connected with mycelium (spawn-threads) growing throughout the adjacent tissue. The dust-like spores are readily detached, float about in the air, and promptly sprout when they settle on a damp surface, sending their germ-tubes into the injured

* "Report on Agriculture for the Year 1909, Fiji."

† H. Tryon in *Queensland Agric. Journ.*, xxviii. 285 (1912); *W. Ind. Bull.*, x. 250.

or ripe surface tissue. Sound fruit can be affected, and young immature bananas may be attacked if they are in the neighbourhood of rotting fruit or vegetable matter. All fruit should be handled as carefully as eggs, as the spores of the ripe rot fungus will soon find out any bruised surface.

The Ripe Rot has caused much damage to bananas in the Canary Islands, and also in Australia. The Jamaican banana is not subject to this disease, but the Chinese banana easily falls a victim.

BANANA SCAB

The earliest stages,* as they occur on fairly well grown but still green bananas, such as would be cut for shipment, are as follows: A reddish-brown colour appears on the green skin in the form of minute transverse markings. These markings soon merge into a uniform brown area, often of considerable extent, some parts of which may become black. In the midst of this dark-coloured area numerous shallow longitudinal cracks make their appearance. Following upon the appearance of the cracks, the skin begins to dry up and take on a greyish-brown colour, the cracks meanwhile assuming larger dimensions. The drying-up extends to the inner layers of the skin, and the pulp is affected, becoming discoloured and dry under the patches of affected skin. Pustules may be found on the diseased skin in the form of minute raised points, which give off spores, by which the disease is spread. Care should be taken to destroy all scabby fruit, and if the disease is prevalent, to spray with Bordeaux Mixture.

* *Agric. Gaz., N. South Wales*, 1903, p. 683.

CHAPTER XIV

INSECT PESTS

THE BANANA WEEVIL BORER (*Sphenophorus sordidus*)

THIS borer, which causes so much damage to bananas, belongs to the family of weevils, the chief feature of which is the rostrum formed by the continuation of the fore part of the head. It is nearly related to the weevil borer of the sugar-cane (*S. sericeus*), but is smaller and of a more uniform dark colour. The annual loss caused in Fiji * by the ravages of this insect probably amounts to many thousands of pounds. It is a most difficult pest to deal with owing to its habits, the whole life-history being spent in the bulb or in the soil.

Effect on the Plant.—Young suckers attacked by the borer wither and quickly die. The first indication that a sucker is attacked is the death of the young leaves while still unrolled. The bulb, when cut open, is found to be riddled by the larvæ. The plants attacked at a later stage in their growth have the appearance of healthy plants, and when a certain stage in the growth has been reached they produce a good bunch, and the presence of the borer does not seem to have affected it. The adult weevils are abundant in the soil about the roots, and also are often found sheltering under dead leaves at the base of the stem.

Habits and Life-history.—The eggs have not yet been discovered, but it is believed that they are deposited singly upon the base of the stem about half an inch above

* "Report on Economic Entomology," by F. P. Jepson, Dept. of Agric., Fiji, 1911.

the level of the soil, as the burrows of the larvæ can be traced from minute spots there. The burrows widen in their course as the larvæ progress, and terminate in a pouch near the surface in which the larva pupates. The larva period lasts about twenty days. A period of from six to eight days from the time of pupation elapses before the emergence of the adult. The adults remain in the soil for some time, and then come to the surface to deposit their eggs. The length of life of the adult is not known; they have been kept in dry earth without food for three months. In all probability the borer continues to breed all the year round, so long as there is a plentiful food supply. A plantation lying fallow for a year would cause the beetle either to migrate in search of food or to be starved. The planting of crops which the borer would not attack upon land previously planted with bananas would have the same effect.

Larva.—The larva is a fleshy, footless, cream-coloured grub measuring 20 mm.* in length and 8 mm. in breadth. The head is light brown in colour, while the cervical shield is pale yellow.

Adult.—The adult beetle measures 14 mm. in length and 4 mm. in breadth. The colour is black. The rostrum is 4 mm. long. The antennæ are elbowed. The elytra, or hard shielding wings, are marked with longitudinal grooves.

Prevention and Remedies.—The banana borer is a very difficult pest to deal with, and it is believed that the only effectual means of dealing with it is by the agency of natural enemies, if they can be found. There is no doubt that a system of rotation of crops would do much to diminish the number of borers on a plantation, as they would in this event either die from starvation or have to seek elsewhere for food. Clean cultivation and the destruction of all old banana stems and roots would eliminate favourite breeding-places.

Experiments have shown that in captivity adults will not live in soil without food for longer than fourteen weeks.

* 2 mm. = one-twelfth of an inch.

In a state of nature they might live a little longer, but as they have not been kept alive with a plentiful supply of food for longer than seventeen weeks, it is not thought that without food they will live longer than about four months. A rotation of crops which would prevent bananas being grown on the same ground for the space of at least a year after the harvesting of the last crop would probably rid the land of many of these insects. Care should, however, be taken to see that no stumps are left rotting in the soil, except as "traps" to attract the beetles. These should be destroyed periodically by burning or burying with carbon bisulphide. Mr. Jepson, the Government Entomologist, proposes to visit certain islands in the East Indies with the object of endeavouring to discover some efficient parasites of this borer which are supposed to exist there.

H. Tryon* states that weevil borers belonging to this genus are found in various tropical countries. *S. sordidus* is found also in the Straits Settlements. The common species of the West Indies is usually named *S. sericeus*, though the Martinique species is *S. lyratus*. *S. obscurus* is found in Papua and the Sandwich, Solomon, and Society Islands, attacking the banana as well as other plants; in Queensland, so far, it is only found in connexion with sugar-cane. *S. musæcola* occurs in Madagascar; *S. striatus* in Guinea and Madeira.

THE BEETLE BORER (*Tomarus bituberculatus*)

The larva damages the banana bulb in the West Indies much in the same way as that of the weevil borer, and its attacks should be met in a similar manner. The adult insect is a large, shiny, black beetle of the typical hard-back form.

* *Queensland Agric. Journ.*, xxviii. 287 (1912).

WHITE FLY (*Aleyrodicus*)

Two species at least of this genus are known to attack the banana. *A. cocois* is a common pest of the coco-nut palm in the West Indies and tropical America, and often migrates in large numbers to banana plantations. The colonies of this minute insect are recognized by the leaves being covered with short wax threads, among which are the immature forms, somewhat like scale-insects, and the winged adults. The wings are covered with a fine waxy dust, like flour. If the pest is at all serious, the best remedy is to cut off the affected leaves and burn them.

THE LARGER MOTH BORER (*Castnia licus*)

This sugar-cane pest also attacks the banana, the larva boring into the trunk in South America and Trinidad.

A LEPIDOPTEROUS PEST CAUSING BANANA SCAB

The banana "scab" of Fiji is due to the destructive agency of the larva of a small moth—as yet unidentified. Slight attacks of scab appear to have no detrimental effect upon the production or quality of the fruit. The way in which the fruit is marked, however, renders it unsightly, and consequently the retailer cannot dispose of bananas so affected as easily as unmarked fruit.

Appearance of Affected Fruit.—The first indication that banana fruit is affected by scab is the appearance of minute longitudinal cracks on the incurved side of the fruit. Later these cracks increase in number and run together, and the whole of this portion of the fruit becomes affected with a brownish discoloration. The skin now commences to dry and the cracks increase slightly in size. If unchecked, the cracks extend through the skin to the edible portion, which then commences to decay.

Habits and Life-history.—When the small cracks referred to are first noticed, examination will reveal the presence

of minute pale yellow larvæ. The small strips eaten away by these larvæ represent the cracks which are so conspicuous in affected fruit.

As soon as the flowering stalk appears, the moth commences to lay its eggs upon the large encircling bract. The larvæ upon hatching enter the bract at this spot and commence to eat the skin of the young banana. The minute thread-like larvæ can be seen in great numbers on the fruit as the bunch appears from the bract.

Prevention.—Pyrethrum dusted on to each “hand” by means of a “puff” ball before the bract has properly opened is recommended by Mr. Jepson as being a very satisfactory method of dealing with this pest.

THE RIPE-ROT FLY (*Drosophila ampelophila*)

Major T. Brown, Entomologist to the Department of Agriculture, New Zealand, has described the fly: * “Length, 2.5 mm. . . . colour variable, usually brownish yellow . . . eyes bright red. *Head* as wide as thorax, with four black setæ on the vertex and about six along the inner margin of each eye. . . . *Wings* large, hyaline, unspotted. . . . This little cosmopolitan fly has become a great nuisance, especially during warm weather, when it attacks all sorts of fruit, more particularly bananas, oranges, and pineapples which have been bruised or begun to decay. . . . It also commits havoc with good fruit that has been cut.”

FRUIT FLY (*Dacus Tryoni* Frogg.)

Mr. H. Tryon writes of this fly † that it punctures the skin of the green banana before it is of full size and deposits its eggs beneath in groups of a few individuals. The position is marked by a small black spot contrasting with the green skin, which widens out later to form a blotch of dis-

* *Bulletin No. 4, Div. of Biology and Horticulture, New Zealand Dept. of Agric.*, 1905, pp. 5 and 6. Quoted in Jepson's Report.

† *Queensland Agric. Journ.*, xxviii. 360 (1912).

coloration. The maggots burrow into the pulp, which becomes soft and brown and soon decays. When the larva is only a few days old it passes out of the fruit and drops on the soil, which it enters to pupate. In due course the pupa gives rise to the fly, which is generally brown coloured with conspicuous pale yellow glossy blotches on the mid-body, the clear wings having two smoke-coloured bands—one all along their fore-borders, the other extending slantingly across them.

Mr. Tryon's recommendations for the prevention of the Fruit Fly are as follows :

(1) The destruction of breeding-grounds adjoining banana plantations. Mangoes, oranges, loquats, peaches, guavas, &c., that are found to be infected should be gathered and destroyed ; if such fruit trees are practically wild, and not a source of income, they should be extirpated as sources of danger.

(2) Formerly the southern States—or Victoria at least—required planters to protect the fruit destined for their markets from fly attack by covering it with Hessian or stocking net, and a special tubular net was manufactured for the purpose. The use of the net is not now compulsory, but it is certainly effective if applied at the time the fruit is two-thirds grown. The natives of Papua wrap their banana bunches with “tapa” or other suitable material to prevent the attacks of injurious animals.

(3) Avoid leaving damaged or defective fruit on the plantation, as it may serve as breeding-ground for the fly.

(4) Learn to recognize the “fingers” that have been “stung,” and detach and destroy them. This procedure is an object of careful provision on the part of inspectors under the Diseases in Plants Act of Queensland.

FRUIT FLY (*Dacus curvipennis*)

Mr. W. W. Froggat, Government Entomologist, New South Wales, has bred out this fruit fly from banana,

shipped from Suva, although no specimens have ever been actually found in Fiji.* This is a handsome dark yellow and black fruit fly, 6 mm. in length, head yellow, eyes purplish black, the dorsal surface of the mid-body covered with a dark shield-shaped black patch, the centre with an elongate double bar of silvery white.

NEMATODE (FLASK-WORM) DISEASE

Dr. Joseph Bancroft investigated † a disease of the banana in Queensland in the year 1879. In the course of the rootlets, and also of the main roots from which these spring, are formed gall-like swellings that ultimately are the sites of decay. The symptoms are the yellowing and death of the older leaves while the suckers are stunted, with a tendency for their leaves to be small and crowded together instead of being large and widely expanding. This disease is due to the development in the root-galls of certain minute worms, and the subsequent decay of the galls and of the roots themselves. Dr. Bancroft named the disease the "Flask-worm Disease" from the form of the worm when mature. The worm is a species of nematode ‡ which was also found attacking the China banana at Cairo, as well as other species of plants. The disease may be combated by ploughing up the fields and leaving them fallow for some time. But the disease is very insidious, as it may be brought from surrounding districts by various agencies, and it is very difficult to eradicate when once started.

A black smut fungus (*Glæosporium musarum*) was also reported. It covered the leaves and spread rapidly. Burning the plants and liming the soil are effective remedies.

* "Report on Parasitic and Injurious Insects," Dept. of Agric., N.S.W., 1909, p. 93.

† H. Tryon in *Queensland Agric. Journ.*, xxviii. 178 (1912).

‡ *Tylenchus radicicola*.

BEES

In Surinam small black bees visit the banana flowers as they open, and in their attempt to obtain the honey exuded by the flower they scar the young fruits. As the fruits grow the scars enlarge, and the bunches are rejected by the inspectors as unsaleable. One estate lost over 15,000 bunches from the effects of the bees in one year, and had to spend a considerable amount of money to destroy all the bees' nests in and around the cultivation. These bees also attack plantains and cacao pods.

GRASSHOPPERS

A somewhat similar scarring of bananas in Jamaica, affecting a large acreage of fruit, was found to be due to attacks by young grasshoppers secreted in the young bunches. The only remedy considered practicable was to hunt for the insects in the bunches and destroy them.

CHAPTER XV

BANANAS AS FOOD

Valuable as Food.—Dr. Robert Hutchison in his classic work, “Food and the Principles of Dietetics,”* says : “That only is to be adjudged a ‘good’ food which contains an ample proportion of nutritive constituents, which is easily digested and absorbed, and which can be obtained at a reasonable cost.” Mr. Eustace Miles adds to this definition that “a good food must be as free as possible from stimulants and irritants ; and, moreover, a good food should for purposes of modern life, when everything tends towards over-acidity and clogging, have certain cleansing properties, or at least should have cleansing foods added to it—among the cleansing foods may be classed many of the fresh fruits, salads and green vegetables.”

It would be difficult to find words more appropriate to use in describing the claims of the banana to a large share in our diet, whether eaten as fresh fruit or cooked in various ways, or as banana flour, or dried like figs.

In the course of a speech delivered on his return from a visit to Jamaica, Sir James Crichton-Browne, M.D., F.R.S., said : “I wish all our school-children could have bananas from time to time. . . . The banana is not a flavoured fruit, that is to say, a little sugar and water with a drop of some essence thrown in, but a food fruit containing, in an agreeable form, all the essential elements of nutrition. . . . As an adjunct to our other foods it is of great value, being at once acceptable to all—for it is not an acquired taste—giving variety to the domestic diet

* Third edition, 1911, p. 19.

table and mingling well with other comestibles. . . . I am quite sure that the Jamaican banana, than which there is none finer or better flavoured when it is of the proper degree of ripeness, is, in the guise of a cheap luxury, a substantial addition to our food supply which is certain more and more to commend itself to the working classes in our large towns."

In a communication to the author, dated December 1912, he writes : " Extended experience of the banana has deepened my conviction of its food value. It is a great boon to the masses of our people, and while retaining its place on the dessert table of the rich, has found its way into the hands of the poor. Its portability, palatability, digestibility are immense advantages, and I am glad to see that it is largely taking the place of the stale sandwich on railway journeys. When in good condition, it is microbe-proof, and it assuredly supplies wholesome nutriment."

The universal experience of mankind, wherever the fruit can be obtained, confirms the opinion of physicians and food experts as to its merits. In some regions the banana and plantain are amongst the principal food-stuffs of the native population. For instance, in tropical America " they are so extensively consumed as almost to take the place of cereal grains as a common article of diet," and in the unripe state, cooked, they supply the staple food of millions of people—" about $6\frac{1}{2}$ lbs. of the fruit or 2 lbs. of the dry meal, with a quarter of a pound of salt meat or fish, form the daily allowance for a labourer " (Johnston and Church).

The celebrated buccaneer and navigator, Dampier, who was an " under manager " on an estate in Jamaica in 1674, in his " New Voyage round the World " (1679-91), speaks as follows of the value of the banana and plantain as food : " When this fruit is only used for bread, it is roasted or boiled when it is just full grown, but not yet ripe or turned yellow. Sometimes, for a change, they eat a roasted plantain and a ripe raw plantain, which is instead

of bread and butter. They eat very pleasant so, and I have made many a good meal in this manner. Sometimes our English take six or seven ripe plantains, and, mashing them together, make them into a lump, and boil them instead of a bag-pudding, which they call a buff-jacket, and this is a very good way for a change. This fruit makes also very good tarts ; and the green plantains, sliced thin and dried in the sun and grated, will make a sort of flour which is very good to make puddings. A ripe plantain, sliced and dried in the sun, may be preserved a great while, and then eats like figs, very sweet and pleasant. The Darien Indians preserve them a long time by drying them over the fire, mashing them first and moulding them into lumps. The Moskito Indians will take a ripe plantain and roast it ; then take a pint and a half of water in a calabash, and squeeze the plantain in pieces with their hand, mixing with the water ; then they drink it all off together ; this they call ' mishlaw,' and it is pleasant and sweet and nourishing, somewhat like ' lambs' wool ' (as it is called), made with apples and ale ; and on this fruit alone many thousands of Indian families in the West Indies have their whole subsistence."

Dr. William Wright, in his " Account of the Medicinal Plants growing in Jamaica," * wrote as follows, more than 120 years ago, of the plantain and banana : " Plantains are cut when full grown, but before they are ripe. The green skin is pulled off, and the heart is roasted in a clear fire for a few minutes, and frequently turned ; it is then scraped, and served up as bread. Boiled plantains are not so palatable. Ripe plantains, sliced and fried, resemble pancakes. The banana is never eaten green ; but when ripe it is very agreeable, either eaten raw or fried in slices as fritters. Plantains and bananas are eaten by all ranks of people in Jamaica ; and but for the plantains the island would scarcely be habitable, as no species of provision could supply their place. Even flour, or bread itself, would be less agreeable, and less able to support the

* *London Med. Journ.*, vol. viii. 1787, p. 272.

laborious negro, so as to enable him to do his business, or to keep in health. Plantains also fatten horses, cattle, swine, dogs, fowls, and other domestic animals."

Mr. H. H. Cousins, now Director of Agriculture, Jamaica, gives * the following percentage analysis of banana flour, prepared by a local firm: Moisture, 10·88; albuminoids, 0·71 (containing nitrogen, 0·114); fats and oils, 0·22; sugar, 3·48; starch, 60·42; pectin, 20·93; fibre, 0·72; mineral matter, 2·64. He continues: "From the chemical composition of this banana flour it is clear that practically the whole of it is readily digestible. The mineral matter contains soluble phosphates such as occur in wheaten flour. This flour consists almost entirely of carbohydrates of a readily digestible nature. The high proportion of pectin imparts to it the mucilaginous properties of a fruit extract. I consider it a well-prepared article of high dietetic value."

But it is not alone in the tropical countries, where the banana plant grows, that it is appreciated. The fact that the fruit ripens after harvesting, that its thick and close-fitting skin is a perfect protection against contamination, and that it is portable over immense distances are all factors which have led to its introduction and use on a large scale in temperate and sub-tropical climates. Its value as food to the teeming populations of large towns is of the greatest importance.

Dr. William Tibbles, in his recently issued work on foods,† says: "The supply of pure food is a means of establishing the health of the people and the betterment of the human race."

Microbe-proof.—When a fruit such as the banana becomes ripe, and still more when it reaches the pulpy stages of over-ripeness, it might well be supposed that micro-organisms are at work, and that very likely the over-ripe fruit might be harmful on that account. This is, however,

* *Journ. Jam. Agric. Soc.*, v. 322 (1901).

† "Foods, their Origin, Composition, and Manufacture." 1912. Preface.

not the case. Dr. Giuseppe Tallarico * has done some very elaborate and exhaustive work on the subject, publishing his full papers upon "Gli Enzimi ideolitici e catalizzanti nel processo di maturazione delle frutta." His main conclusions † are twofold: First, that the pulp of the banana remains absolutely free from microbes so long as the skin is intact; cultivations upon bread, agar, gelatine, &c., remained completely sterile. Secondly, that the maturation of the fruit is due to ferments, of which there are three main kinds—amylotic, invertive, and proteolytic, each of which is present in quantity in the ripe banana. It is perhaps on this account that the fruit is so beneficial in many cases of simple dyspepsia.

Digestibility.—It is necessary, however, to utter a note of warning that bananas when eaten as fruit should be perfectly ripe, otherwise they may be difficult of digestion with some people. It is easy enough to ascertain whether bananas are ripe, for when really ripe there is no longer a trace of green, even at the ends, and the skin has begun to shrivel and darken. The *British Medical Journal* says: "In their native countries they are seldom eaten before the skin is discoloured, and the pulp so soft that it can be scooped out with a spoon." Dr. Wm. Tibbles ‡ says: "The banana is fit to eat as soon as it has lost all the green colour, and remains fit, no matter how black it may be, so long as the skin is unbroken; for until the latter occurs, there can be no admission of air and no decomposition."

The *Journal of the American Medical Association* puts the necessity of perfect ripeness very plainly as follows: "It has been stated that the banana is difficult of digestion, and may be the cause of alimentary disturbance. The reason why the banana has achieved this reputation would appear to be that it is often partaken of before it is ripe, and the fruit is imported green, and is ripened by artificial

* *Archivo di Farmacologia sperimentale e scienzeaffinio.*

† *Tropical Agriculturist*, 1908, ii. 79.

‡ "Food and Hygiene," second edition, 1910.

heat, a process which may be hastened or delayed to some extent according to the demands of retail trade. The green banana contains, after removal of the skin, about 1.5 per cent. of protein, and 20 to 25 per cent. of carbohydrate, which is almost entirely starch. In the ripe banana, the ripeness of which is evidenced by the yellow-brown peel, there is from 16 to 19 per cent. of carbohydrate, almost entirely in the form of sugars, and the remainder of the edible pulp is mostly water. Bananas are usually eaten uncooked, and the ingestion of the amount of raw starch contained in the unripe fruit or the fruit which is not completely ripened is often the cause of irritation in the alimentary tract. Yet many people eat the partially ripened fruit and decline the ripe fruit with the brown skin on the supposition that it is rotten. Another point which has contributed to the reputation of the banana is that, owing to its shape, there is not the necessity for that efficient comminution which is desirable, and this has led to the food being often gulped down in a manner prejudicial to digestion." Dr. Tibbles, in "Food and Hygiene," says: "Raw fruit is very wholesome, and is especially beneficial to those who dwell in towns, but is not so easy to digest as cooked fruit."

Cooking Bananas.—There are many methods, as Dampier has told us, of preparing the banana as food besides the usual way of eating it as a ripe fruit. It may be interesting to note also those mentioned by Père Labat as in use in the French West Indies two hundred years ago:

"Bananas may be roasted on the grill, then the skin is removed and they are eaten with sugar and the juice of an orange. Or they may be cooked in a stew-pan like pears with wine, sugar, cinnamon and cloves, when they assume a beautiful red colour and have a delightful and delicate taste and smell, very good *pour la poitrine* and very nourishing; they are cut in two according to their length. Sometimes they are cut into thin slices, dipped into a ready prepared batter, and fried as fritters." Messrs. Elders and Fyffes (Bow Street, Covent Garden, London) have pub-

lished an elegant little booklet of recipes for cooking bananas. "Paper-bag Cookery Manual," by C. Hermann Senn, also contains many useful recipes. A selection of these is given in the Appendix.

Preserved Bananas.—Père Labat continues: "To preserve them like figs, raisins, and other dried fruits, they are allowed to ripen thoroughly in the house, in which condition the skin is very easily removed; they are then cut lengthwise into four, and dried on a trellis-like stand in the sun or in an oven after the bread has been baked; the fruit becomes covered with white sugary powder deposited from its own juices. In this condition they will keep for years."

"Banana figs" are now prepared in Jamaica and exported in increasing quantities (*see* Chapter XXXI); they are also dried in India to supply a local demand (*see* Chapter XXIII). Their special value, as Labat points out, is that they keep well. It has been stated that experiments are being made in Austria with banana figs as part of the army rations; and for all purposes where it is of consequence to have food in small compass, which keeps well and is available for eating as bought, or when cooked, banana figs form an ideal provision. A housekeeper with a store of them has always the material at hand for toothsome dishes. They are packed in pound cardboard boxes which contain fifteen to twenty of the fruit. The price, sixpence a box, is within the reach of all.

Banana Flour.—Again, Père Labat says: "The Indians make a paste from the fruit, which they carry with them on their voyages, serving them as nourishing food and drink. Those who wish to make this paste with more care, dry the bananas at first in the oven or in the sun, then they grate them, mix them with powdered sugar and a small portion of powdered cinnamon, clove and ginger, ever so little flour and the white of an egg to bind all these things together; this mixture is made into small cakes which are dried in the oven or sun, and are very good and nourishing."



FIG. 9. A BANANA PLANT

From "Nouveau Voyage aux Isles de l'Amérique." Par
le Père Jean-Baptiste Labat. Paris, MDCCXXI.

Banana flour is made from the fully grown unripe banana, that is, before the starch is changed into sugar in the ripening. It is difficult to peel green bananas, but if they

are first put into scalding water (176° F.) for four or five minutes, the peel is easily removed. The peeled fruit is dried in the sun or put into a dryer of some kind to reduce the percentage of the water which it contains from 70 to 15. The drying is more readily effected if the fruit is cut up small. Steel knives should not be used as they turn the banana black ; nickel blades are better, and very effective knives can be made from bamboo. The peasantry in Jamaica, after taking off the skin, cut the bananas into thin slices and lay them on stones in the sun. One day's hot sun is sufficient to dry them, after which they are put into a mortar, pounded, and then sifted. Two bunches make ten quarts of flour.

In the factory at one time in operation at Montpelier, Jamaica, belonging to the Hon. Evelyn Ellis, the bananas were dried in a vacuum, the interior of the vacuum apparatus being heated. The bananas enclosed in this dryer were stirred continuously by means of paddles which alternate and move between fixed knives. The paddles were moved by a system of belts and pulleys. The drying was complete in two hours ; by this time the bananas had been reduced to the appearance of somewhat coarse flour with only 15 per cent. of water. The mass was removed from the dryer, and passed through sieves containing 120 meshes to the square inch. Whatever remained on the sieve was passed through a simple mill and sifted afresh. The flour was packed in boxes or barrels lined with paper. The odour was that characteristic of the fresh banana, the flavour agreeable, and the taste somewhat sweet. It has been found, however, that the result is more satisfactory if the bananas are simply dried and exported as " banana chips," as the making into flour, sifting, &c., can be better done in England.

Dr. Robert Hutchison * says : " The unripe banana is dried and used to produce banana meal or flour. A sample of such a flour had the following percentage composition :

* " Food and the Principles of Dietetics." By R. Hutchison, M.D. Edin. Third edition, 1911.

			Moisture	Proteid	Fat	Carbo- hydrates	Mineral Matter
Banana Flour	.	.	13.0	4.0	0.5	80.0	2.5
Wheat Flour	.	.	13.8	7.9	1.4	76.4	0.5

I have placed alongside of it the composition of good wheat flour, compared with which the banana meal is rich in carbohydrates and mineral matter, but very poor in proteid. If rice, on the other hand, had been taken for comparison, it would have been found that banana flour was about equal to it in nutritious value."

The *Lancet* * says : " For some reason not yet explained, the starch of the banana is much more digestible than are the cereal starches, besides which the fruit contains a notable proportion of nitrogenous material."

At the meeting of the British Medical Association in July 1910, Dr. Eric Pritchard † recommended the use of banana flour in infant feeding. He stated it was cheap and wholesome, rendered the milk more digestible, and possessed a high nutritive value. He has for many years recommended the addition of mashed banana to the milk mixtures with which babies are fed when the natural source is unavailable. As the result of further experiments, he proposes the substitution of banana flour, made into a gruel or decoction, for the more expensive proprietary infant foods. It is of great importance that infants should be trained early to digest cows' milk. This cannot be done by giving them artificial substitutes which are pre-digested. The use of cereal decoctions and solution of gum or gelatine undoubtedly makes the digestion of cows' milk easier, and Dr. Pritchard finds that a decoction of banana gruel has many points of recommendation. It can be made in a few minutes by rubbing up a heaped table-spoonful (1 oz.) of banana flour with a pint of water, and then boiling for five minutes. A gruel made in this way has excellent colloidal properties when added to milk in equal quantity ; it thickens the milk and prevents forma-

* The *Lancet*, February 1900.

† *Brit. Med. Journ.*, Oct. 15, 1910.

tion of a leathery coagulum of casein, and satisfies the appetite of hungry infants more effectually than simple milk dilutions.

Banana flour can be obtained under the name of "Bananine," of which the *Lancet** speaks highly in the following terms: "There can be no doubt of the nutritious character of banana flour, and the starch in it is peculiarly easy of solution and digestion in the alkaline digestive juices of the body. Banana flour is readily dissolved, for example, by the saliva. Our analysis of 'Bananine' gave the following results: moisture, 14.60 per cent.; mineral matter, 2.20 per cent.; proteid, 19.22 per cent.; fat, 2 per cent.; and carbohydrate, 61.98 per cent. The flour has the peculiar flavour and odour of fresh banana fruit. We have received also a sample loaf, made with 'Bananine' flour. The flour proves to make a very acceptable loaf, uniform in texture and permanently moist, and of a golden colour."

It has been found difficult to make banana bread unless the banana flour is mixed with a large proportion of wheat flour, but bread of an agreeable taste has been obtained by making a paste of the banana flour, and then submitting to the action of steam under pressure.

"Bananine" is prepared by a Liverpool firm, the Banana Bread Flour Food, Ltd., 16 Brunswick Street. Banana flour and other banana preparations are also manufactured by Pattinson's Banana Fruit Foods, Ltd., Anerley, London, S.E. The banana flour is vouched for in their circulars as follows: "Dr. Conrad Stich, the food expert, of Leipzig, writes: 'I have carefully analysed and tested your banana flour, and have noticed how peculiarly soluble it is. By the addition of hot water the whole of the flour is made perfectly soluble and in a form very suitable for digestion. Four-fifths of the flour consists of soluble carbohydrates. It is particularly suited for patients recovering from typhoid fever, and is excellent in cases of choluria, dysentery, and similar stomachic complaints. In

* The *Lancet*, Oct. 17, 1903.

cases of chronic dyspepsia and gastritis, the banana flour properly prepared is easily digested. I consider that as an infants' and invalids' food the flour properly prepared with milk has a great future. The nitrogenous portion of the flour is of great value, being of a fruit nature and remaining quite soluble in the flour.'"

Pattinson's banana and flaked oats, another preparation for a breakfast food, is recommended as follows: "The chemical analysis and general examination of this product proved eminently satisfactory. It bore every evidence of having been carefully blended from choice bananas and Scotch oats of high quality. The addition of the banana not only confers valuable anti-scorbutic properties, but it increases the digestibility of the combination, so that those who cannot ordinarily take oaten preparations can take 'Banana Oats' with the best results. Being pre-cooked it is more easily assimilated than dishes made from raw oatmeal, and when prepared according to directions, it contains all the essentials of a perfect diet.—J. GRANT-STEPHENS, D.Sc., Ph.D."

The *Journal of the Society of Arts** reports: "An alimentary product of the banana is now announced, consisting of the pulp of the banana ground to flour and mixed with triturated cocoa, milk powder, and extract of malt. The process of manufacture consists in volatilizing the essential oil from the peel, adding it to banana flour, and mixing with it a proportion of dried milk powder and pure extract of malt, and also the paste prepared from cocoa, and finally adding a sufficient quantity of sugar for flavouring. This composition is said to possess all the essential elements of a complete food in a concentrated form, namely, albuminous matters or proteids, fatty substances, and hydrocarbons."

Composition of Bananas.—Dr. Wm. Tibbles, in his latest work on foods,† gives the results of his study of the banana as follows: "The fact that the fruit will ripen after separation from the plant, and loses little of its real value

* *Journ. Soc. Arts*, March 1907.

† "Foods: their Origin, Composition, and Manufacture," 1912.

by being separated, has led to its being transported long distances from the place of cultivation. . . . They are largely used for food wherever they grow, and in some regions they constitute one of the principal foodstuffs of the native population. They are very prolific, and an acre of land set with bananas will produce more food than the same area set with potatoes or wheat. . . . Bananas are among the most nutritious fruits, but consist chiefly of carbohydrates, and especially sugars. The starch consists of long, narrow granules with indistinct striæ and hilum. The proportion varies according to their condition. Ricciardi* found that green bananas contain 12 per cent. of starch, which mostly disappears during ripening, along with the tannic and organic acids. Doherty† found 6 per cent. of starch in ripe fruit; but other observers find less than this, most of it being converted into sugars and other soluble carbohydrates. The woody fibre does not exceed 2 per cent. The sugars in *ripe* fruit average about 20 per cent. of the edible portion, but Doherty found as low as 3 per cent. sugar and 11 per cent. of other carbohydrates. The proteins are small; in ripe fruit they average 1 per cent. of the edible portion, and consist of albumin and gluten. The acidity equals 0.3 per cent., reckoned as sulphuric acid. The ash varies from 0.5 to 1 per cent. (*see* the second table on p. 120),‡ being 0.70 per cent. in Niño, 1.08 in Orinoco, and 0.83 in Colorado bananas.

“In some countries the banana and plantain form a far more important article of food than in Europe. To an immense portion of the human race it occupies the place of wheat, rye, barley, and potatoes, used by inhabitants of temperate regions. A reference, however, to the analysis given below shows that the banana is deficient in proteins and fat. It contains less of these elements than the cereals do. The proportion of protein and fat places it on a par with the potato, but with the advantage that it is unneces-

* Biedermann's *Centralb. f. Agrik. Chem.*, xiv. 18.

† *Chemical News*, 1892, lxxiv. 187.

‡ *Bureau of Chemistry, Bulletin* 87, U.S. Dept. of Agric.

COMPOSITION OF THE ASH PERCENTAGES

—	Niño	Orinoco	Colorado
K ₂ O	46.46	52.41	51.47
CaO . . . .	.95	1.02	.37
MgO . . . .	.42	1.90	.65
P ₂ O ₅	10.36	5.16	3.25
SO ₃	2.36	3.32	2.77
Cl	6.59	8.48	7.63

COMPOSITION OF BANANAS—PERCENTAGES

—	Water	Protein	Fat	Carbo- hydrate	Fibre	Ash	Authority
Edible portion:							
All analyses .	75.50	1.26	.50	21.70	.81	.76	Tibbles
Average .	75.30	1.30	.60	22.00	—	.80	{ Atwater and Bryant
Plantain .	73.90	4.80	.63	19.66	.20	—	{ Coren- winder
Dried Fruit .	29.20	5.30	2.30	55.80	—	5.30	{ Farmers' Bulletin 293
Banana Flour:							
All analyses .	11.10	3.55	.83	81.70	1.50	2.23	Tibbles

sary to cook it. The fresh fruit is too bulky, however, to form a satisfactory ration, for one must consume 1400 grammes (nearly 50 oz.) in order to obtain 300 grammes of carbohydrate; which, moreover, would contain but 21 grammes of protein and very little fat, and would yield only 1400 calories. It is true the protein and fat deficiency could be made up by drinking milk, whereby more carbohydrate would also be taken. Weight for weight, it is somewhat inferior in nutriment to potato. . . . A comparison of banana flour and wheaten flour or oatmeal is also to the disadvantage of the fruit, and shows it to be

deficient in protein and fat as compared with the cereal products, but it is a more valuable source of carbohydrate."

NUTRITIVE VALUE OF BANANA AND OTHER FOODS COMPARED

—	Banana	Banana Flour	Wheat Flour	Oatmeal	Potatoes
Moisture . . .	75.50	11.10	14.0	8.9	78.3
Protein . . .	1.26	3.55	11.4	15.5	2.2
Fat . . .	.50	.83	1.0	10.1	.1
Carbohydrate . . .	21.70	81.70	75.0	54.8	18.4
Mineral matters . .	.76	2.23	1.7	4.0	1.0

Dr. R. Hutchison * says : "The *food-fruits* are not to be despised as sources of real nutriment. Of this group the banana is a good example. In the fresh state this fruit contains a fair amount of carbohydrate and an appreciable amount of proteid as well ; while bananas dried in the sun compare favourably with dried figs in nutritive value." He continues later : "Weight for weight, dried figs are more nourishing than bread, and a pint of milk and six ounces of dried figs make a good meal." Of dates he says : "The date is as much a staple article of diet to the Egyptian as rice is to the Hindu, but the carbohydrate of rice is mainly in the form of starch, whereas in the date it is almost solely present as sugar. 'A half-pound of dates and half a pint of milk make an ample and satisfying meal for a person engaged in sedentary labour' (Densmore)." The table on p. 122, taken from Dr. Tibbles' work,† shows how much alike these three fruits are in their composition.

The quick growth of an appreciation of the importance of the banana as food among those who have not known it hitherto as a common article of food like the cereals and

* "Food and Dietetics."

† "Foods : their Origin, Composition, &c."

AVERAGE COMPOSITION—PERCENTAGES

Dried Fruits	Water	Protein	Fat	Carbohydrates		Ash	Fuel Values : Calories per pound
				Nitrogen-free Extract	Crude Fibre		
Bananas .	29.2	5.3	2.3	55.8	2.1	5.3	1240
Figs .	18.8	4.3	.3	68.0	6.2	2.4	1475
Dates (refuse 10.0)	15.4	2.1	2.8	74.6	3.8	1.3	1615

potatoes is very well illustrated in the following statement * by the United States Consul at Port Antonio, Jamaica :

“While Jamaica exported nearly twice as many bananas last year as any other country, the United States imported more than five times as many as any other country. For the fiscal year ended June 30, 1912, the bananas imported into the United States reached the enormous total of 44,520,539 bunches, valued at \$14,368,330, an average of 32.3 cents a bunch, as the market value shown in American consular invoices certified at the shipping ports. Great Britain imported during the calendar year 1911 a total of 6,714,479 bunches, value \$8,943,099, an average of \$1.33 cents a bunch, the value fixed at the importing ports. During the same year the value of bananas (including banana food products) imported into Germany amounted to \$1,974,046. It should be stated that some of the bananas imported into Great Britain are sent to Germany and other countries of Northern Europe, and that Hamburg, which is a great distributing centre, ships bananas arriving at that port to Scandinavia and elsewhere. . . . Estimating the average number of bananas at 140 to the bunch, it appears that the people of the United States consume over 6,000,000,000 bananas a year, or more than five dozen for every man, woman, and child in the United States, including Alaska

* *United States Daily Consular and Trade Reports*, December 26, 1912.

and Hawaii. As indicating the rapid increase in the consumption of bananas in the United States it is interesting to observe that the value of this fruit imported during the fiscal year ended June 30, 1900, was \$5,877,835; in 1905, \$9,897,821; in 1910, \$11,642,693; and in 1912, as already stated, \$14,368,380, which shows an increase of 23·4 per cent. in the last two years and of 144 per cent. in twelve years. The gain in Great Britain last year was 8·4 per cent., in Germany last year 24 per cent., and in the last two years 111 per cent. Owing to direct shipments of bananas from Caribbean countries now being made to German as well as to British ports, the Hamburg-American Steamship Company having, it is said, acquired a substantial interest in the Atlantic Fruit Company, and a concession of banana lands having been made by Colombia to a German company, it may be regarded as certain that the imports of this fruit into Germany will show a large advance from year to year. The increased facilities recently provided for direct shipments of bananas to British ports justify the belief that the consumption of bananas in the United Kingdom will show substantial gains in future years.

“The increasing consumption of bananas in a number of countries naturally raises the question of an adequate supply to meet the coming demand. In Jamaica, where the immense banana crop is produced on about 3 per cent. of the total acreage of the island, there is yet plenty of suitable land available. In Mexico, Central America, Panama, and Colombia, not to mention the large possibilities of Haiti and the Dominican Republic, there are vast tracts of land where fertile soil, a warm climate, and abundant rainfall favour the production of bananas on a large scale. Not only is there land enough, but the profits of the crop are sufficiently remunerative to attract the investment of ample capital to meet the world's demand.

“As all the conditions seem to be favourable for a greatly enlarged production of bananas, and as the highly

nutritive qualities of this fruit are becoming more generally recognized, it is encouraging in this day of high cost of living to have good reasons for believing that the banana is destined to play no small part in meeting the world's insistent demand for a larger and cheaper supply of wholesome food."

CHAPTER XVI

BANANAS IN MEDICINE

IN considering the claims of banana flour, it has been shown how valuable it is for patients suffering from gastric troubles.

Sir H. M. Stanley in "Darkest Africa" (ii. 239), gives his testimony as follows: "The Awamba understood the art of drying bananas over wooden gratings for the purpose of making flour. . . . If only the virtues of the flour were publicly known, it is not to be doubted but it would be largely consumed in Europe. For infants, persons of delicate digestion, dyspeptics, and those suffering from temporary derangements of the stomach, the flour, properly prepared, would be of universal demand. During my two attacks of gastritis, a light gruel of this, mixed with milk, was the only matter that could be digested."

In India, the native home of the banana, medical men prescribe not only the fruit, but also many other parts of the plant, as remedies.

The "Dictionary of the Economic Products of India" contains numerous extracts from the opinions of medical men in India on the value of the banana plant in medicine. Civil Surgeon R. A. Parker, M.D., states: "A combination of ripe banana, tamarind, and common salt is most efficacious in dysentery. I have used it in many cases, both of the acute and chronic forms of the disease, and seldom failed to effect a cure. It may, in fact, be said to be a specific, and I can confidently recommend it to the profession as well as to the public. It is simple, easily procurable, and may safely be administered to a

child. It is not disagreeable to take, has no bad effects, and is on the whole preferable to ipecacuanha. In simple cases a single dose is sufficient ; as a rule, three or four doses are required to effect a cure. The patient should be kept quiet and placed on low diet. The dose for an adult is : Ripe bananas one ounce, the pulp of ripe tamarind half an ounce, common salt quarter of an ounce ; well mixed and administered immediately. It may be given two or three times a day." Civil Surgeon J. H. Thornton, B.A., M.B., says : "The juice of the tender roots contains a large quantity of tannin and is used with mucilage for checking hæmorrhages from the genital and air passages. The ashes produced by burning the plant contain a large amount of potash salts, and are used as an antacid in acidity, heartburn, and colic. The tender fruit is used for patients suffering from hæmoptysis and diabetes." C. T. Peters, M.B., says : "The ripe fruit is useful in chronic dysentery and diarrhœa. The dried fruit of the larger varieties is a valuable anti-scorbutic. The dried leaves, and in fact the entire plant, are burnt, and the ashes, dissolved in water and strained, yield an alkaline solution, containing chiefly potash salts, which is used in curries, especially as a cure for acidity and an anti-scorbutic." Ainslie writes that the banana is "one of the safest of fruits for such as have delicate stomachs, being entirely free from acidity ; it is, moreover, very nourishing, and is always prescribed as food by the Hindoo practitioners for such as suffer from bile and heat of habit."

CHAPTER XVII

WINE, WHISKY, AND ALCOHOL FROM BANANAS

Loss on Small Bunches.—In countries that produce bananas for export there is a very considerable number of bunches that are too small or are otherwise commercially unfit for export. In all the exporting countries put together there are probably as many as eight million bunches that annually fail to come up to the high standard rightly insisted upon by the shippers. In Jamaica alone, it has been calculated that over three million bunches are produced annually which cannot be profitably exported.*

* Note, for instance, what the Secretary of the Jamaica Agricultural Society says below (*Journ.*, x. 164, 1906): "It is instructive to visit one of the buying depots for bananas where the sellers are mostly small cultivators. All through the day and night long lines of carts and drays, donkeys, and mules arrive loaded with bananas, and carts holding up to thirty bunches, the drays up to forty, the donkeys carrying four and the mules six, generally. What is peculiarly depressing is the tremendous amount of waste that occurs. The number of rejections shows clearly enough how much instruction is needed by the small cultivators not only in the growing of bananas, and in the timing of them for the season, but of the cutting of the right grades. Just at this time (end of March), when full three-quarter fruit is wanted for the United States, we noticed a whole cart-load rejected, all for being too thin. The fruit wanted three weeks to fill. Another cart-load had ten stems out of twenty-five rejected, another seven out of thirty, and so on. None of these rejections were for bruises, all for being too thin fruit, and yet these cultivators have been cutting fruit every season for years. In many cases the cause of thin fruit, no doubt, is greed—the same spirit that actuates men to offer unfit oranges, half-cured coffee and cocoa, and so on—but at least in an equal number of cases it is the want of knowledge, and here we find men coming fifteen to thirty miles hauling fruit for which they get nothing, and over and above have had the wear-and-tear of their beasts and cart, and their time is lost, when by waiting two weeks their fruit would have been cheer-

Some of these may be consumed or given to cattle, but it is impossible to utilize the great majority in this way and great loss results. The value of the eight million bunches, reckoned at sixpence each, is a matter of £200,000 per annum, and about £80,000 to Jamaica alone, which represents a considerable loss to planters in the aggregate.

Various attempts have been made from time to time to make use of this fruit and avoid the loss. It had already been demonstrated very many years ago that bananas can be made into flour or dried like figs, or utilized in making alcohol, and the knowledge has been, to some extent, turned to account in the present day.

Banana Wine.—Consideration has already been given in these pages to the preparation of flour and banana figs, but only a small proportion can be utilized in this way, and it remains to consider the use of bananas in manufacturing an alcoholic spirit. It is well known that an excellent fermented drink can be made from bananas and plantains. Ligon, in his "History of Barbados" (1657), gives the following account of the preparation: "But the drink of the plantine is farre beyond all these; gathering them full ripe and in the height of their sweetness we pill off the skin and mash them in water well boyl'd, and after we have let them stay there a night, we straine it and bottle it up, and in a week drink it; and it is very strong and pleasant drinke, but it is to be drunk

fully bought. And at this particular time of the year, waiting can by no manner of means be a loss, because if the price alters at all it will be a rise." A writer in the *Philipp. Agric. Rev.* (March 1912) bears witness to the loss on the largest estates: "It is said the demand is rapidly increasing for all kinds of banana products. The source of the material for these products is the small or over-ripe bunches discarded at the dock in loading the fruit steamers for the United States and Europe. Bunches having less than six hands are considered too small for the regular trade; any bunch showing even a few fruits that are beginning to turn yellow are also discarded in the warehouse at the time of loading the cargo. The writer has seen this deplorable waste of material at Port Morant, in eastern Jamaica, where the United Fruit Company has one of its largest plantations; bunches are flung overboard, or fed to the cart oxen, with apparently no thought for the real food value of the fruit."

sparingly for it is much stronger than Sack, and is apt to mount up into the head."

Dampier, in his "Voyages," tells how banana wine was made in Jamaica: "When they make drink with them, they take 10 or 12 ripe plantains and wash them well in a trough; then they put two gallons of water among them; and this in two hours' time will ferment and froth like wort. In four hours it is fit to drink; and then they bottle it, and drink it as they have occasion; but this will not keep above 24 or 30 hours. Those, therefore, that use this drink, brew it in this manner every morning. When I first went to Jamaica, I could relish no other drink they had there. It drinks brisk and cool, and is very pleasant."

Speke mentions that plantains in Central Africa yield "a wine resembling hock in flavour."

Stanley in "Darkest Africa" relates that "two large troughs—equal in size to small canoes—were stationed in the village, in which the natives pressed the ripe fruit and manufactured their wine."

Dr. Parke, in his "Personal Experiences," says: "Nelson treated us to some *pombé* (banana wine) to-day; it was really very good, although made from bananas which were not at all ripe. This beverage is prepared by cutting two or three bunches of ripe bananas into pieces of half an inch in length, adding two gallons of water, and leaving it to stand. On the third day it is really a delicious drink. At first it has a sweet tart taste, which after four or five days becomes very acid. In a day or two more it changes to a fluid, having qualities very like those of vinegar."

Banana Spirit.—The possibility of utilizing the banana fruit in the production of alcohol has been more than once under the consideration of the Academy of Sciences of France, and the following information is taken from a paper read before the Academy of M. B. Corenwinder.*

It had already been shown by Buignet that during

* "Comptes Rendus," vol. 88, 293, 1879.

the whole growth of this fruit the saccharine matter is constituted entirely of cane-sugar, but the proportion varies considerably. From results of analyses by Corenwinder himself, it appears that a sound ripe banana fruit contains as much as 22 per cent. of its weight of sugar, 16 per cent. being crystallizable and the remainder uncrystallizable. In the mature sugar-cane the proportion of cane-sugar present is, according to Payen, 18 per cent. After the banana has become quite ripe, there is a rapid diminution in the proportion of crystallizable sugar and an increase in the proportion of inverted sugar, but not to the same extent. An over-ripe fruit, the flesh of which had become very mellow, contained only 2.48 per cent. of crystallizable and 11.84 per cent. of uncrystallizable sugar, being a total of 14.68 per cent. or two-thirds of the original quantity.

Analyses were made by Corenwinder on bananas (*Musa Cavendishii*) received from Brazil, on the edible portion of the fruit deprived of its rind. Analysis of a ripe banana gave :

Water	72.450
Crystallizable sugar	15.900
Inverted sugar	5.900
Cellulose	0.380
Nitrogenous substances (0.342 N.)	2.137
Pectin	1.250
Fatty matter, organic acids, &c.	0.958
Inorganic matter	1.025
	<hr/>
	100.000

Estimates of the sugars made day by day until rottenness began to set in gave the results shown on p. 131.

Corenwinder concludes his paper as follows: "Ainsi que MM. Marcano et Muntz, je pense que la banane pourrait être l'objet d'une importante exploitation industrielle, notamment pour produire un alcool excellent. En France, on met souvent en fermentation, dans les usines, les mélasses avec du jus de betterave. Dans les pays chauds, pour regulariser les fermentations de mélasses

Day	Condition of the Fruit	Crystal- lizable Sugar	Uncrystal- lizable Sugar	Total
1	Ripe, sound, flesh still firm .	15.90	5.90	21.80
2	„ „ .	15.72	6.34	22.06
3	„ „ .	15.10	6.43	21.53
4	„ „ .	14.28	6.69	20.97
5	Riper, flesh soft .	12.25	8.95	21.20
6	Very ripe, flesh soft .	10.16	8.92	19.08
7	„ „ .	9.26	9.75	19.01
8	„ flesh sleepy (blette) .	4.51	11.70	16.21
9	„ „ .	3.13	12.90	16.03
10	„ flesh very sleepy .	2.84	11.84	14.68

de canne, il y aurait peut-être avantage à faire *un pied* avec du jus de banane qui fermente spontanément et à faire couler dans ce pied pendant qu'il est en fermentation, la mélasse étendue de la quantité d'eau convenable, en prenant la précaution, bien connue des distillateurs, de faire les additions du liquide fermentescible par intermittence et avec lenteur."

Banana Whisky.—Experiments* conducted at the Central Laboratory of Guatemala in association with the director of a distillery at Puerto Barrios, Guatemala, led to the production of a very good spirit, which is said to be something like whisky, from bananas which were about to be thrown away. Samples of this spirit were sent to the St. Louis Exposition that had only been in barrel for six months, and were recognized to be of superior quality. After analysis by the laboratory of the Department of Agriculture in Washington, the producers were awarded a gold medal. Alcohol ages so rapidly in tropical countries that one year in the barrel is sufficient to make the product very fine. Corn whisky must be kept in casks for several years before being offered for consumption, and at least five years to obtain the best qualities. Banana whisky is ripe at the end of one year. The cost of manufacture is said to be much less than that of ordinary whisky. The

* *Journ. d'Agric. Trop. and Cuba Review.*

yield may be estimated at $4\frac{1}{2}$ litres (about one gallon) per bunch of bananas. A memorandum of expenses made for a plant capable of producing 150 casks of whisky daily aggregated 827,500 francs; this included buildings, machinery and apparatus, fuel, labour, administration, general expenses for two years, cases and bottles for the preparations of one year, and raw material for manufacture for two years (270,000 bunches at 75 centimes each).

The manufacture of banana wine has lately been undertaken by MM. Guerin and d'Héerille in Saigon, Cochin China. The bananas are crushed, mixed with a small amount of water, and then, upon the addition of yeast, allowed to ferment until the starch and sugar are changed to alcohol. The wine, "besides being much cheaper than ordinary spirits, is said to have a delicious perfume."

Bananas in Brewing.—In 1894, experiments * on a larger scale were carried out by Herr Kahlke, at his Manufactory of Yeast and Alcohol at Königsburg, on the use of banana meal in brewing, and an account of them was published in the weekly paper *Alcohol*. Herr Kahlke wrote as follows: "Banana flour without doubt, from its richness in starch and its good flavour, is particularly suitable for the manufacture of yeast. This flour is easily rendered saccharine. The yeast obtained by adding banana flour to the other ingredients has a good colour, all the requisite properties of an excellent class of yeast, and moreover keeps well. The alcohol obtained from it leaves nothing to be desired, so that this flour may be introduced as an article of commerce, and employed without any special preparation." Satisfactory experiments have also been made in some breweries, where 20 per cent. of malt has been replaced by the flakes and flour of bananas. The flavour of beer was not altered, and the quantity of liquid was increased, and the malt was replaced by a less expensive substance. One of the great Belgian brewers wrote: "These flakes were macerated in the vat with the malt, and the result was much superior to that of maize. . . .

* *Bull. Bot. Dept., Jamaica, New Series, i. 115 (1894).*

Briefly, the use of the flakes may be considered both advantageous and easy in brewing."

Banana meal * from peeled unripe bananas is mashed with malt extract and then fermented with yeast, 100 kilogrammes of meal yielding 47·8 litres of alcohol. When mashing is carried out without malt extract, the diastase naturally present in the meal being used, the yield of alcohol is considerably lower.

Denatured Alcohol from Bananas.—Any one interested in the manufacture of alcohol from bananas should read some such small and cheap treatise as "Distillation of Alcohol and Denaturing," by F. B. Wright, published by Spon, London and New York. It goes to show that an immense industry has arisen in Germany in connexion with the production of alcohol from potatoes, and it follows that much might be done on somewhat similar lines with the banana. According to Mr. Wright, the common form of alcohol known as *denatured spirit* or *methyiated spirit* consists of alcohol to which one-tenth of its volume of wood alcohol or other denaturizing agents has been added, for the purpose of rendering the mixture undrinkable through its offensive odour and taste. As it is sold duty free, it is applied to a variety of uses to which, from its greater cost, duty-paid spirit is commercially inapplicable. Mr. Wright states that "it is Germany which has led the way in the manufacture and use of denatured alcohol or *spiritus*, as it is there known. Germany has no natural gas or oil-wells, and gasoline and kerosene are not produced there, hence the necessity of using some other form of liquid fuel. This fuel—in many ways better than any petroleum product—was found in alcohol." The agricultural districts of Germany produce abundant crops of potatoes and beets. "From the first, alcohol can be so easily manufactured that the processes are within the understanding and ability of any farmer"; it is also made from the crude molasses from beet-sugar factories. "Under these circumstances and the great demand for

* *Journ. Soc. Chem. Ind.*, xxxi. 453 (1912).

liquid fuel for motor carriages and gas engines, alcohol for denaturing came rapidly to the front as one of the most important of agricultural products, as one of the most valuable *crops* which a farmer could raise." The potatoes are manufactured into alcohol in individual farm distilleries and in co-operation distilleries. "A recent exhibition in Germany gave a good illustration of the broad field in which denatured alcohol may be used. Here were shown alcohol engines, alcohol boat motors, and motors for threshing, grinding, wood-cutting, and other agricultural purposes. The department of lighting apparatus included a large and varied display of lamps, chandeliers, and street and corridor lights, in which alcohol vapour is burnt like gas in a hooded flame covered by a Welsbach mantle. Under such conditions alcohol vapour burns with an incandescent flame which rivals the arc light in brilliancy and requires to be shaded to adapt it to the endurance of the human eye. . . . Similarly attractive and interesting was the large display of alcohol heating stoves, which for warming corridors, sleeping rooms, and certain other locations are highly esteemed. . . . Cooking stoves of all sizes, forms, and capacities, from the complete range, with baking and roasting ovens, broilers, &c., to the simple tea and coffee lamp, were also displayed."

Much importance is being attached in English engineering circles to the proposals for superseding petrol by alcohol produced within the country. It is contended that by the systematic cultivation of potatoes and other root crops, and the remission of the Government duty, alcohol could be retailed to the consumer at 1s. per gallon. The retail price of petrol to-day is about 1s. 7d. per gallon.

The *Pall Mall Gazette* gives the views of an expert on the advisability of substituting alcohol for petrol as a fuel, "In the first place he points out that the two great oil fields of the world, the Russian and the Pennsylvanian, have practically become exhausted, though there may be reserves of heavy oil 'held up' on the fields themselves in view of a coming shortage. In that case, the fractional

distillation process might, and probably would, be employed to keep up the supply of petrol for the market. But this, of course, could be only a temporary expedient. There would come a time when the stock of petrol thus obtained would be at an end. Then the turn of alcoholic fuel would arrive. This the authority in question regards as so far-reaching in its effects that the result of its introduction is described by anticipation as a social revolution.

“To make this clear to the general reader it is necessary to observe that petroleum, the source of petrol, kerosene, paraffin, and the heavier rock oils, is a natural product. The supply, therefore, like that of coal, is limited. On the other hand, alcohol can be manufactured by a process of fermentation from vegetable products, such as beet and potatoes.

“Quite clearly, one important result of a utilization of alcohol as a fuel would be an enormously increased demand for it. To meet this demand, it would be necessary to increase proportionately the sources of supply. This would have to be done by enlarging the area of potato and beet growing, to meet the necessities of which rural labour would undergo a material change for the betterment of the agricultural industry. Potatoes and beet would be grown for the industrial purpose of supplying alcohol as a fuel, and the question of ‘back to the land’ would thus, to a considerable degree at any rate, automatically solve itself.”

The comparative fuel values of gasolene and alcohol, especially from the point of view of the motor industry, have, according to the *Pharmaceutical Journal*, been the subject of an inquiry by the American Bureau of Mines. Some two thousand tests were made to ascertain the comparative value of heavy fuel oils and alcohol for internal-combustion engines. The heating value of one cubic foot of an explosive mixture of alcohol and air, having theoretically just sufficient air for complete combustion, is approximately equal to that of a similar explosive mixture of gasolene vapour and air, but the

alcohol mixtures can be compressed to much higher pressures without pre-igniting than the gasolene mixtures. For 10 h.p. to 15 h.p. engines of the usual type, a pressure of about 180 lbs. above atmospheric pressure was found to be the maximum for alcohol, whereas only 70 lbs. could be obtained with gasolene. Although a different type, the alcohol engine can be constructed equal to the gasolene engine in adaptability to service. A gasolene engine having a compression pressure of 70 lbs., but otherwise as well suited to the economical use of alcohol as gasolene, will, when using alcohol, have an available horse-power about 10 per cent. greater than when using gasolene.

CHAPTER XVIII

DRYING BANANAS FOR FLOUR AND FIGS

THE manufacture of flour and figs from bananas is an industry which is already becoming important in Jamaica, and is carried on to some extent in several other banana-producing countries. It is necessary therefore for each individual manufacturer to consider the principles and the various methods of drying which have been in use for other fruits and for different materials, in order to decide on that system which is most appropriate for his own use.

Drying in Sun.—The object of drying any material is to prevent deterioration by fungous growth, which can only do its destructive work in the presence of moisture. The simplest and most natural form of drying fruit, cocoa, coffee, &c., is that made use of in all parts of the world, namely, to expose them to the action of the sun and air. In cloudy weather and at night the material is put under cover to prevent a deposit of moisture by dew or rain. Small lots can be carried to cover, but where large amounts are dealt with, this is not convenient. Cocoa in bulk is often dried on wooden platforms, arranged one above the other on rails, so that they can be run out from under a roof, free from one another, and easily put back when necessary. Coffee and pimento are also dried occasionally in this way, but more often on large cement platforms, on which the berries are spread in thin layers, and from which they can be pushed by a rake-like wooden tool into air-tight huts at the sides of the platform. Fruit is often dried on a small scale in boxes or frames covered with glass, raised on posts above the ground, and provided with

hinged ventilators on the sides near the bottom and top, which can be opened at the bottom on the side from which the wind is blowing, and at the top on the opposite side ; so that the moist air above the fruit may be carried off, and the whole structure shut up tight in case of rain and at night. This method has also been successfully applied to the drying of coffee, as an aid to the ordinary method, by B. S. Gosset in Jamaica, but the glass structure is of large dimensions—a modification of the horticultural hot-house.

Artificial Driers.—Exposure to sun and air is most effectual, but frequently the sun is obscured by clouds for days or weeks at a time, and the wind may be already laden with moisture. The uncertainty of the weather has led to various methods of artificial drying by which the conditions can be kept under control. The easiest plan on a small scale is to apply heat from a stove or from waste steam. A high temperature may, however, be injurious to flavour, and a fermentation change may cause some deterioration. This has led to the adoption of the vacuum driers, where a moderate heat is sufficient, or to a system of drying by air deprived of moisture,* but not heated.

Drying Closets or Rooms.—If a high temperature is not injurious, a closet or room of any convenient dimensions may be used, and the stove placed either inside or outside. Ventilators are provided as in the glass receptacles. The higher the temperature, the greater is the amount of water which the air can take up, but the saturated air must be carried off by some means, or the material will simply be steamed, and the moisture re-deposited when the air cools. Full and free ventilation is of the utmost consequence. If a stove is used, the situation of the furnace some feet below the room may create a sufficiently strong current of warm air through the inlet pipe to enable it to pass out by a simple outlet, but this is only in case there are no surroundings and no down-blow of external air. If there is a chimney in the room, it may induce a natural draught, or

* See Spon's "Workshop Receipts," iii. 455 (1909).

the air may be extracted by a fan. In order to secure that the hot air penetrates in all directions, both inlet and outlet should start at the bottom of the room. The inlet pipe should come in as near the centre of the floor as possible. The outlet pipes, of which there may be two or more, should start near the floor at the greatest distance from the inlet, and conduct the wet air to one junction outlet pipe at the ceiling. This junction pipe should be provided with a valve at its base, which may be opened to start the draught, and then kept closed. If steam is employed for heating, it is conducted by pipes near the floor on each side of the room. The inlet openings are arranged along the pipes, and the pipes are encased in partly grated casings so that the incoming air may be brought into close contact with the hot pipes. In this case the outlet pipes may have their openings above the shelves on which the material to be dried is placed. Spon * states that "the minimum size of fresh-air duct and outlet shaft should be one square foot area for every 500 c. ft. of space in the room (when empty), this being a room, say, 8 ft. each way; and the outlet shaft should be at least twice as high as the room, say 16 ft. or higher. With a higher shaft a smaller area would suffice. These sizes are for drying rooms for a laundry; for substances of a drier nature, smaller ducts and shafts, with a corresponding decrease in the air supply, may be used."

Blackman's Fans.—The illustrations on p. 140 show a building suitable for use with Blackman's fans and hot air. The building is made of galvanized sheet steel; one measuring 40 ft. by 20 ft. by $12\frac{1}{2}$ ft. will give a drying surface of 5000 square feet. The shelves can be drawn out on runners from one or both sides of the building, so that the bananas can be sun-dried when the weather conditions are favourable.

In this type of drier the air is blown through the heaters into the drying chamber by two fans, and then over and under the trays on which the produce is spread. To

* "Workshop Receipts," i. 492 (1909).

obtain the maximum drying effect, the air can be further circulated by means of a large fan placed near the roof of the building.

The temperature of the incoming air can be regulated

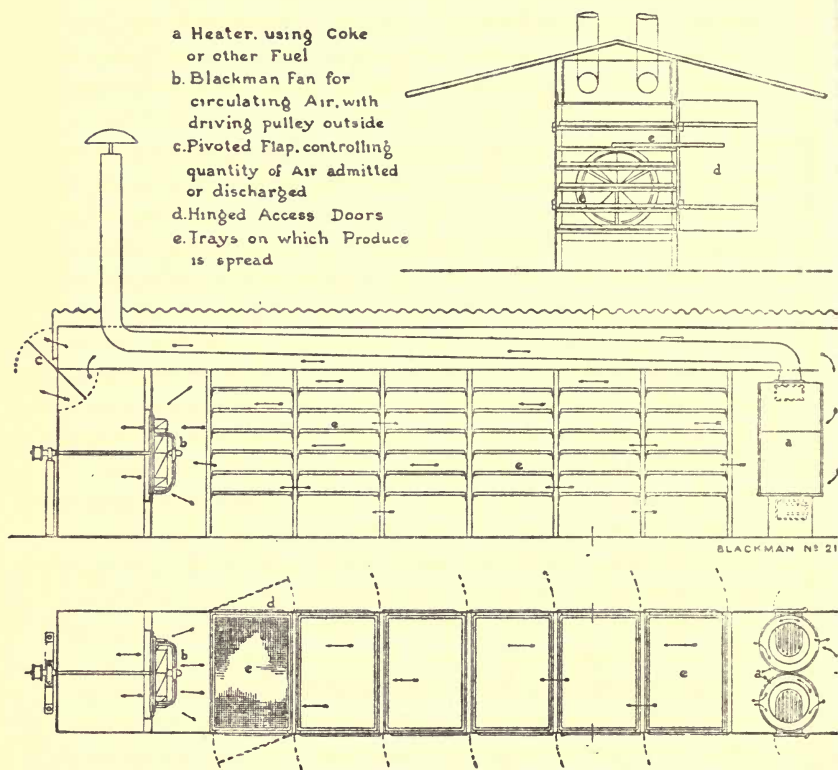


FIG. 10. PLAN AND ELEVATION OF DRYING HOUSE, WITH SHELVING FOR USE WITH BLACKMAN'S FANS AND HOT AIR

by means of the valve provided under the heaters, whereby a certain amount of cold air can be mixed with, and so temper, the hot air entering the room, depending on the amount of opening. Further control is obtained by a second opening provided in the end of the rooms opposite to the fans.

The amount of warm circulating air can be varied within wide limits, and the direction of the air current can be reversed if required. The trays are interchangeable, so that the material may be moved from one part of the drier to another if desired, or taken elsewhere for the bananas to "cool off" after drying, to prevent it forming mould. Such an installation can easily be erected and looked after by an intelligent person. The building costs £270.

The *Wolff system* is worked either by live or exhaust steam for drying tropical produce—bananas, copra, cocoa, rubber, maize, coffee, ground nuts, &c.—from two tons per day and upwards.

By this system the material to be dried is carried in trays on skeleton trucks running on light steel rails through a long, low, cheaply built shed, in which the air is heated by steam pipes on the ground level. The condensed steam is automatically returned to the boiler. The temperature is lowest at the end where the trucks make their entrance through large doors. The process is thus continuous, beginning with a comparatively low temperature, which gradually increases as the line of trucks is moved forward, and as the front truck containing the fully dried material leaves the building, another is joined to the train at the cool end.

The temperature is never so high as is necessary when the air has to be introduced so heated that it will be able to traverse the drying house without becoming too cool to be serviceable at a distance from its source. It can be very easily controlled, so that it need never exceed that which is best suited to the material in hand. When the quantity to be dealt with is less than the full capacity of the drier, it is best to reduce the firing and give more time.

There is no complicated machinery to require the attendance of an engineer. A simple boiler and fixed steam pipes, with no moving parts, can be looked after by an intelligent labourer.

The trucks have roller bearings, so that a whole train

of fourteen trucks can be easily moved by hand when necessary to advance them in order to take out a truck of fully dried material at one end and introduce at the other end one of fresh produce.

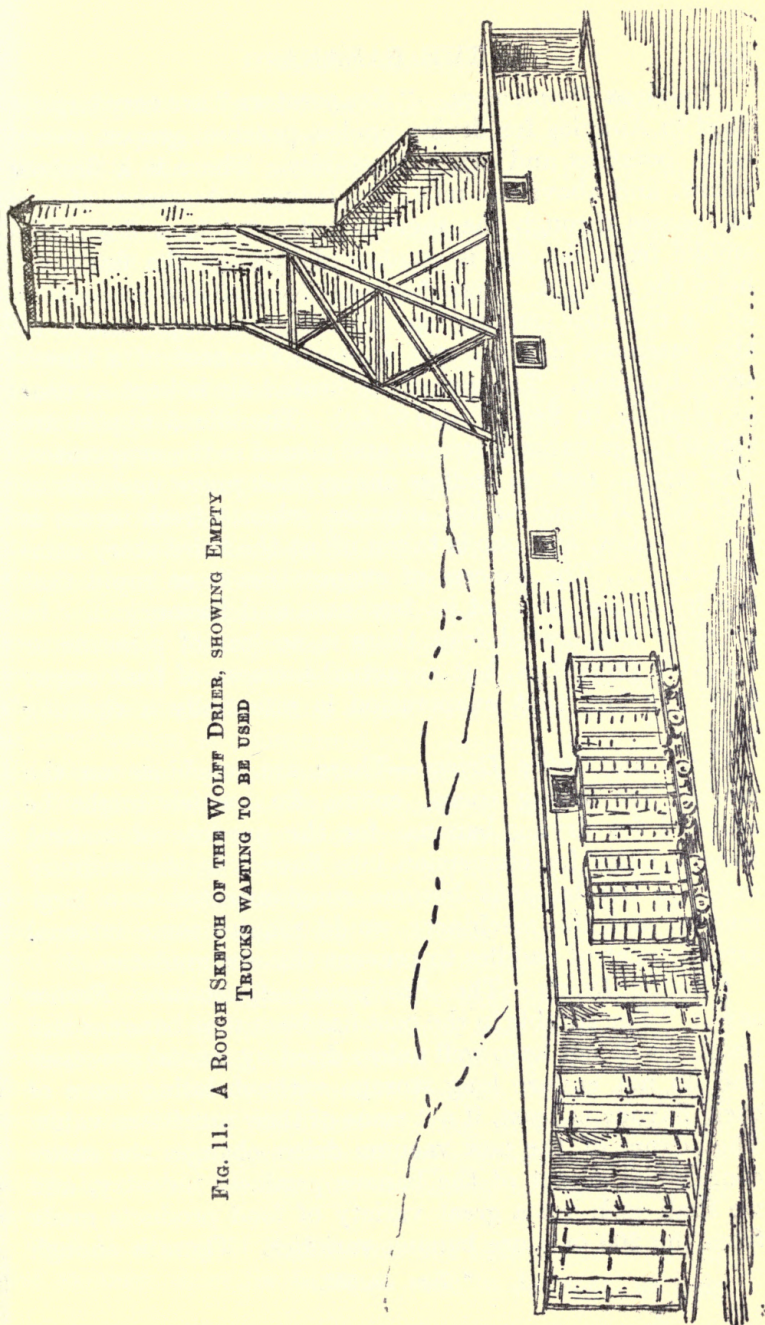
Each truck has 144 square feet of carrying surface, and will contain from 5 to 10 cwt. of produce. The drier, fully charged, would therefore accommodate from 18 to 36 tons. Taking a safe average of 20 tons, the plant would treat 10 tons of wet produce per day, allowing two full days for the passage of each car through the building. This would require a comparatively very low temperature—a great advantage when it is necessary to avoid as far as possible all risk of loss of flavour or essential oils. Any increase in temperature would, of course, increase the output by shortening the time occupied in drying.

The building illustrated on p. 143 is 19 ft. wide and 6 ft. 6 in. high, to take five rows of trucks; and if made 100 ft. long, to take fourteen trucks in each row, it would be large enough to turn out, easily, five tons of copra per day, and bananas, cacao, rubber, &c., in proportion.

The whole plant is supplied complete by the Wirewove Roofing Company, 108 Queen Victoria Street, London, E.C., including a foreman to supervise and assist the installation.

Seventy trucks, containing 2500 trays, together with the steam pipes, weigh 30 tons, and the cost is £800. If a boiler is required, a sectional boiler is recommended—Handley's water tube boiler, which can be conveniently carried in sections; it weighs in all 6 tons, and costs £250. An ordinary boiler would cost only £100, but it would probably weigh 20 tons, and is therefore inconvenient for handling. A man is sent out to put the plant in working order; his expenses for the voyage and 16s. per day would be charged to the purchaser. The present position of the banana-drying industry would not justify a large capital expenditure, but if it were possible to combine it with the drying of copra on a large scale, this system may well be adopted as being practical.

FIG. 11. A ROUGH SKETCH OF THE WOLFF DRIER, SHOWING EMPTY
TRUCKS WAITING TO BE USED



American Evaporators.—"Evaporators" are very largely used in America for drying apples, peaches, grapes, sweet corn, potatoes and other vegetables. There is a firebox below, and above are movable shelves. A stream of hot air passes through the shelves and out into a flue; the smoke from the fire is conducted through the flue, and helps the draught. Spon * speaks of one kind of evaporator as "a chamber running from the top of a large furnace in the basement upward, out through the roof of a three-story building. The current of heated air is kept as near as possible to 240° F. (116° C.). The sliced apples are spread on galvanized screens and placed in the evaporator. The screens rest on endless chains that move upwards at intervals of three to five minutes, when a fresh screen is put in below, and one is taken off at the third story completed. . . . The process of evaporation is so rapid that the fruit loses none of its freshness and flavour. . . . In properly evaporated fruit there is no loss of pleasant or valuable properties, but an actual increase of fruit sugar, from the fact that evaporation is essentially a ripening process."

Cocoa and Coffee Driers.—There are machines on the market for drying cocoa, coffee, &c., which might be adapted for drying bananas for the purpose of making banana chips for conversion into flour. In the ordinary machine the bananas become conglomerated into large masses, and the machinery would require some internal arrangement of paddles to prevent this accumulation.

Vacuum Driers.—The *Philippine Agricultural Review* says: "The trouble in the past has been that bananas and plantains do not keep well unless dried by special processes and do not endure long storage without losing some of their flavour at least, if not some of their nutritious value. The advent of the new vacuum driers changes the entire commercial aspect of the banana-products industry, and we shall soon see a great variety of food products made from the 200 or more banana varieties. There is enough

* *Tom. cit.* 503.

waste ground adapted to banana culture in the Philippines to-day to supply a large portion of the food of 25,000,000 people, if the new methods of handling that wonderful crop were put into operation."

The system of drying in a vacuum deserves consideration.

Exhaust steam of low pressure is usually employed as the medium for conveying heat to the vacuum apparatus. The total heat contained in 1 lb. of steam at 212° F. is about $5\frac{1}{2}$ times more than that contained in 1 lb. of water at the same temperature, and it is owing to this large amount of latent heat in steam that makes it so suitable for conveying the heat to drying apparatus. After the material has been placed in the vacuum-drying apparatus, the air is removed by a pump, until a vacuum of about 28 in., or more, is maintained. When the moisture in the material has been warmed up to only about 100° F., the boiling-point is reached, and the moisture is quickly evaporated. The greater the heat, the quicker is the evaporation; but the temperature of the moisture, and that of the material being dried, is not increased, so long as the vacuum is maintained and some moisture remains. By observation glasses and other means it is known when all the moisture has been evaporated, and the material is then removed from the drying apparatus.

Comparing vacuum and air drying apparatus, the saving of heat is considerable in the vacuum apparatus. In the case of the vacuum-drying apparatus, the wet material and its moisture absorb the whole of the heat supplied. The only additional heat required is that lost by radiation and the warming up of the material and moisture to the boiling evaporating temperature. Owing to the short time required for drying under vacuum, these driers are much smaller than air driers working under atmospheric pressure, and therefore the surfaces exposed to cooling are much less, and the loss by radiation is comparatively small.

Emil Passburg, of Berlin, was the manufacturer of the first vacuum drier for bananas used in Jamaica, as long

ago as 1898. It was introduced by Mr. O. Zurcher, the manager at Montpelier for the proprietor, Hon. Evelyn Ellis. It was of the revolving drum type, and was said to turn out five tons of dried banana flour every week for some time. An improved model is now recommended, and may be taken as a type of what is required under this system. It consists of a rectangular cast-iron vacuum chamber with surface condenser and steam-driven vacuum pump.

The vacuum-drying chamber is designed to remove the water rapidly and at a low temperature. The chamber is iron, closed hermetically by a door. It contains a number of closed heating shelves, arranged one above the other, in which small pipes are fitted for the admission and exit of the heating steam. The shelves are as a rule made strong enough for a test pressure of 90 lbs. On these are placed trays containing the material to be dried. After the door of the drier, which is fitted with an india-rubber joint, has been closed, a high vacuum of at least 28 in. of mercury or more is created by means of the air-pump, while exhaust steam passes through the heating shelves. At a very moderate temperature of the material that is to be dried—about 95° F. (35° C.)—the water, owing to the vacuum, begins to evaporate briskly out of the substances, which therefore dry rapidly. The charging of the chamber is simple and easy, and the working clean and reliable. The temperature can be regulated by valves in the steam pipes. The drying, of course, is independent of climatic conditions. By using hot water for heating with an air-pump giving a high vacuum, the evaporation of the water contained in the materials that are to be dried takes place at as low a temperature as 63° F. (17° C.).

The driers work with a very small consumption of steam. As a rule, only 13 to 15 lbs. of heating steam are required to evaporate 10 lbs. of water out of the previously heated substance that is to be dried. This includes the motive power for the air-pump, where the exhaust steam from the air-pump engine is used for heating purposes.

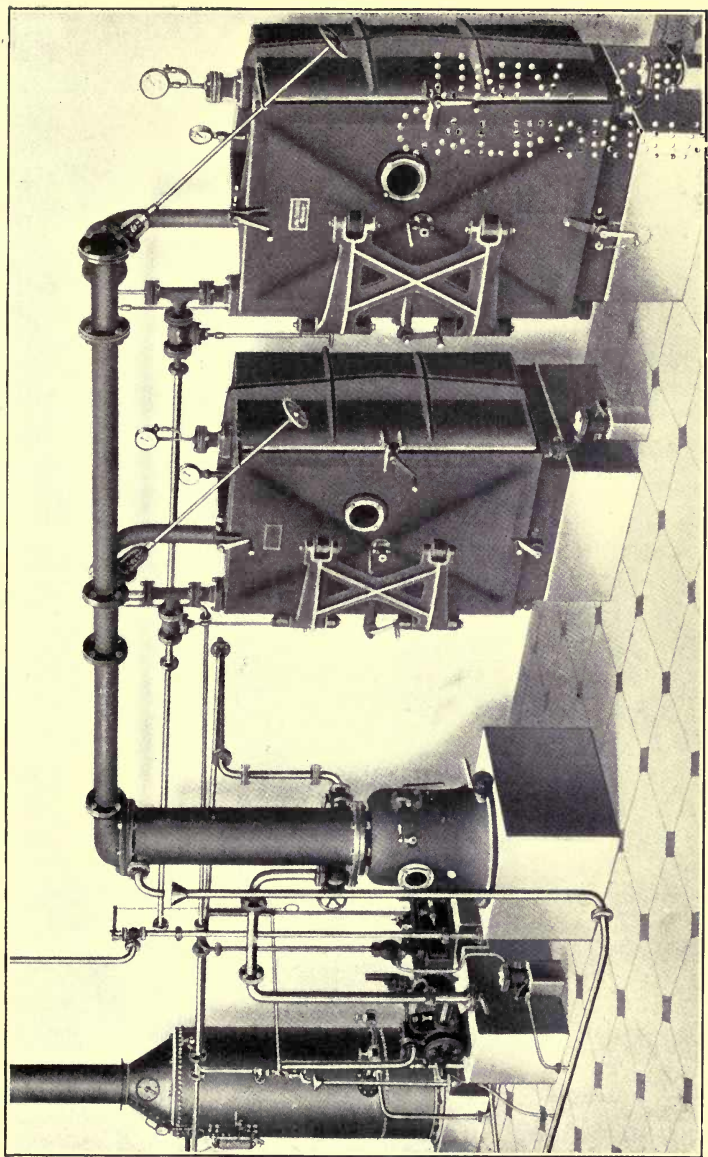


FIG. 12. A VACUUM DRYER



Such an economical consumption of steam is only possible by drying under vacuum.

A vacuum-drying plant faces p. 146 (Fig. 12). The size recommended for drying bananas is known as No. 12; there are twenty shelves in its chamber, $43\frac{5}{16}$ in. wide, $39\frac{3}{8}$ in. long, and 1 in. high, with a space between the shelves of $2\frac{5}{16}$ in. The approximate total heating surface is 496 sq. ft. The chamber is made of cast iron; it is 8 ft. 8 in. high, including the stand, 5 ft. wide, and 5 ft. 3 in. deep. The approximate weight of the plant is 5 tons 6 cwt. With one chamber, as shown, the price is £500; but two chambers, forming a unit, are recommended instead of one, price £900. Seven or eight hundredweight of bananas can be dried in the day.

Although this drier appears to be excellent for making banana chips, it is not so certain that it is well suited for the preparation of banana figs.

CHAPTER XIX

MANILA HEMP AND OTHER FIBRES FROM SPECIES OF MUSA

Manila Hemp.—The cultivation of the species of *Musa* (*M. textilis*) which yields Manila hemp is discussed under Philippine Islands (Chapter XXV). Wherever the conditions are somewhat similar to those in the Philippines, this is probably the best species to grow for the production of fibre; but it is possible that a species may be found in Africa which will suit local conditions there better.

In Java in 1911 the total area * devoted to Manila hemp and other *Musa* fibres was 4694 acres. Experimental trials in Java with Manila hemp have given good results, although the fibre is not of so fine a quality as that of the higher grades produced in the Philippines. The cultivation is not remunerative on land where the raw material cannot be transported cheaply, or in plantations where the production falls below 850 lbs. per acre. The plant requires in Java a loose soil, rich in humus, and situated not more than 1650 feet above the sea. Under favourable conditions the production may amount to as much as 1½ tons of dry fibre per acre. The cultivation of other crops on the same estate is advisable, but Manila hemp should not be grown in admixture with other plants. If possible, it should be grown on land which is adapted for a central factory. A system of local factories distributed over a large estate can only be recommended in cases in which the configuration of the land does not admit of cheap transport of the raw material. If Manila hemp is to be the principal crop

* *Bull. Imp. Inst.*, x. 301 (1912).

grown on the estate, the area planted should not be less than 450 acres, although if grown as a secondary crop, 90 acres may be profitable.

A sample of Manila hemp grown at the Government Experimental Garden, Kullar, Madras, at an elevation of 1300 feet, was reported on by the Imperial Institute * as being inferior to ordinary Manila hemp; it was regarded as well adapted for the manufacture of binder twine, and was valued at about £23 to £24 per ton (October 1908).

Wild Banana Fibre.—Wherever there is a very large local supply of “wild bananas” which yield a good fibre, it may be profitable to work up this supply, just as it pays in Mauritius to extract hemp from the wild *Furcraea*, although it would not be profitable in any other colony to plant *Furcraea* for the purpose.

Samples of fibre of *Musa Ensete* and *M. ulugurensis* from German East Africa have been chemically examined and reported on by the Imperial Institute.† The commercial experts to whom the fibres were submitted reported that they were of very promising quality. The “first quality” of *Musa Ensete* was stated to be of good bright colour, well cleaned, readily saleable in the London market, and probably worth about £50 per ton. The “second quality” was considered to be inferior in colour but of good quality, and worth £45 per ton. The fibre of *Musa ulugurensis* was regarded as a very useful material, but inferior to that of *Musa Ensete*; its value was estimated at £40 per ton. The results of this investigation have shown that these East African *Musa* plants would no doubt prove well worth cultivating for the sake of their fibre, which, if carefully prepared, would obtain a ready sale at good prices.

Samples of wild banana (*Musa Livingstoniana* and other *Musas*) from Nairobi, British East Africa, were reported on by the Imperial Institute,‡ and the opinion of the commercial experts was that these products are comparable

* *Bull. Imp. Inst.*, vii. 10 (1909).

† *Ibid.*, iii. 226 (1905).

‡ *Ibid.*, v. 228 (1907).

with the best fibres used for ropemaking, are similar to the most expensive grades of Manila hemp, and would meet with a ready sale in the London market. The seven samples varied in the valuation from £20 to £50 per ton, based on the current prices of the best grades of Manila hemp, which varied at that time from £43 to £57 per ton.

A sample of fibre from a species of wild *Musa* from Tenasserim, Burma, was lately examined at the Imperial Institute,* and the fibre was reported to be clean, lustrous, well prepared; the strength was good, and the length varied from 4 ft. to 5 ft. 6 in. A commercial firm to whom the sample was submitted regarded the fibre as particularly valuable on account of its softness, and valued it nominally at about £20 per ton, with "fair current" Manila hemp at £22 to £22 10s. per ton in the London market. There is no doubt that fibre of this quality would be readily saleable in the United Kingdom.

Manila hemp plants are being experimentally cultivated at Mazeras in British East Africa,† and have made satisfactory growth. Several acres at Cainville, Limoru, have been planted with the indigenous "wild banana" (*Musa* sp.), which is widely distributed in the Protectorate. It is propagated from seed, and usually requires from two to two and a half years to reach maturity. A useful fibre is obtained from the sheaths by a method of beating, scraping, washing, and drying; but this mode of preparation is both expensive and unreliable. If a satisfactory machine were introduced, there is no doubt that a profitable industry could be established, as not only could the wild plants be utilized, but a permanent supply could be readily obtained by cultivation.

Banana and Plantain Fibre.—Banana fibre from Southern Rhodesia was sent to the Imperial Institute,‡ and the brokers reported that this was a somewhat soft fibre, of fair strength, stronger and more even than is

* *Bull. Imp. Inst.*, x, 536 (1912).

† *Ann. Rep. Dept. Agri., Brit. E. Africa*, 1909-10, 99.

‡ *Bull. Imp. Inst.*, ii, 168 (1904).

usually the case with banana fibre, and worth £25 to £26 per ton.

Plantain and banana fibres from the Gold Coast have been reported on at the Imperial Institute.* The plantain fibre was regarded by commercial experts as worth £40 per ton (with good Manila hemp at £38 to £42 per ton); and the banana fibre £36 per ton (with fair Manila hemp at £35 to £36 per ton).

The following is the report of a Committee appointed to consider the extension of the cultivation of fibre plants in India,† so far as it refers to plantain fibre :

“There are possibilities in India of a useful industry in plantain fibre. In many parts the plantain is common in every garden ; and in Bengal, Assam, the Bombay and Malabar coasts, the Delta tracts of Madras, and in parts of Burma, whole groves of plantains are quite common. The fibre of the plant which produces good fruit is usually, however, far inferior to that of *Musa textilis*, the source of Manila hemp. Moreover, the amount of fibre obtainable from a plantain in India is small. Experiments have shown that the fibre can be extracted by a simple hand-machine ; but, in view of the low market price obtainable—as a rule, not much more than half that of Manila hemp—it remains to be proved that a plantain fibre industry in India is a commercial possibility. The fibre is of little use for the manufacture of cordage as its strength is below the standard usually demanded for ropemaking. There are about 124,000 acres under plantains in Burma, but nothing is done with the fibre. The crop might give paying results for fibre after producing fruit.”

The question of the value of fibre from the stem of the banana comes up again and again for discussion in the West Indies, although it was practically settled many years ago when Sir D. Morris was Director of Public Gardens and Plantations, Jamaica. The stem yields less than 1½ per cent. of its weight—that is, about 1½ lbs. per

* *Bull. Imp. Inst.*, vi. 240 (1908).

† *Agricultural Research Inst., Pusa, Bulletin No. 15*, July 1909.

ordinary stem as cut. This fibre is described by experts as being "very weak, poor colour, and woody," and as being "only fit for paper worth about £7 or £8 per ton." To obtain one ton of fibre it would therefore be necessary to handle nearly 100 tons of fresh stems, which must be dealt with as soon as cut, and on the spot. This no doubt could be managed if it were worth while, but as the local prices would probably not exceed 1*d.* per lb. it is scarcely likely that any serious attempt will be made to extract it.

If it is considered also that the value, as manure, of the chopped stem is perhaps two or three times the value of the fibre, no reasonable person would wish to export fibre to the detriment of his land.

No doubt better fibre, as good as that submitted to the Imperial Institute from Africa and Burma, could be obtained if the trunk were cut at the emergence of the flowering stalk from the top of the plant; but the banana and plantain are grown primarily for the fruit, and not for fibre.

In 1905, when the subject was under discussion, Sir D. Morris sent the following communication to the Jamaica Agricultural Society: *

"I enclose a summary of the facts obtained as the result of experiments during the last twenty years. They are as follows: A banana stem just after fruiting, if cut, as usual with the country people, about two feet above ground, and denuded of its foliage, weighed 108 lbs.; this, being divided into three lengths of $2\frac{1}{2}$ ft. each, and split longitudinally into several pieces, was prepared by beating and washing by hand, and yielded 25 oz. of clean marketable fibre, which is at the rate of 1.44 per cent. of the gross weight. The fibre of the lower portion of the stem, as also the fibre in the petioles of the leaves, was not extracted.

"A smaller banana, cut under similar circumstances, that is, two feet from the ground, and denuded of its

* *Journ. Jam. Agric. Soc.*, x, 2 (1906).

foliage, weighed 41 lbs. This was divided into two lengths of $2\frac{1}{2}$ ft. each, and after being split longitudinally into several pieces, was prepared by hand, and yielded $6\frac{3}{4}$ oz. of clean fibre, or at the rate of 1.02 per cent. on the gross weight.

“At the Hope plantation similar experiments were conducted with banana stems which yielded very much the same results. Two banana stems, cut after fruiting at two feet from the ground, and denuded of their leaves, weighed 147 lbs. These yielded 33 oz. of clean fibre, or at the rate of 1.44 per cent. on the gross weight.

“From ordinary stems of banana, cut after fruiting at about $1\frac{1}{2}$ to 2 ft. above ground, a settler might prepare about $1\frac{1}{2}$ lbs. of clean fibre; but if the stems are large, and if the whole length is used as well as the petioles of the leaves, the amount of the fibre might be increased to $2\frac{1}{2}$ lbs., if not 3 lbs., per stem.

“The reports submitted by leading firms of fibre brokers on the above samples of Jamaica banana fibre were as follows: Messrs. Ide and Christe, *Banana Fibre*: ‘This is only fit for paper worth about £7 or £8 per ton.’ Messrs. Collyer and Co., *Banana Fibre*: ‘No market for this; very weak, poor colour, woody; nominal value £14.’

“It must be borne in mind that to obtain one ton of banana fibre it will be necessary to handle nearly 100 tons of fresh stems. These cannot be carried to a central place for treatment, otherwise the cost of the fibre would be increased beyond its market value. The stems will be required to be dealt with on the spot. It is probable that for banana fibre bought in Jamaica not more than £6 per ton (or less than 1d. per lb.) could be offered for it.

“At the time I was investigating banana fibre I suggested that ‘the merchants who purchase the fruit from the growers might offer a small sum for clean and well-dried fibre, and take it in small lots as it comes to hand. The merchants could afterwards sort and pack the fibre and put it up in tightly compressed bales for shipment. Some

such plan as this, suited to local circumstances, would probably offer the best means of starting a banana-fibre industry in the West Indies.' Whether it would pay or not would depend on the purpose for which the fibre is used and the market value at the time."

CHAPTER XX

DEVELOPMENT OF THE BANANA TRADE

United Fruit Company.—In 1867 the Governor of Jamaica, Sir John Peter Grant, pointed out in his annual report that the value of all the fruit exported from the island during that year was only £728, although no country was better suited by nature for the production of fruits of great market value. He instituted in the driest district a system of irrigation which proved to be of the greatest value to the island in later years, when at length planters woke up to the fact that bananas could be most profitably grown there. The enterprise of the Boston sailor, Captain L. D. Baker, was, however, the chief factor in the astonishing increase in the fruit trade. He began by shipping a few bunches in the vessel in which he traded between Boston and Jamaica; then the Boston Fruit Company was established by him to supply steamers and deal with bananas as cargoes. The demand for the fruit spread from Boston throughout the States. The cultivation of the fruit was extended to Costa Rica, Panama, Colombia, and Cuba. Bananas were shipped to other ports, to New York, Baltimore, and New Orleans for convenience of transport inland. The Boston Fruit Company became the United Fruit Company with larger interests and more extended operations.

The development of the trade has been phenomenal, and is very largely in the hands of the United Fruit Company of Boston, with whom Messrs. Elders and Fyffes, of London, work in close association. The United Fruit Company are owners of twenty-five steamships of approximately 117,252 tons gross register, and Messrs. Elders and Fyffes of sixteen

of approximately 70,139 tons gross register ; these, with fifty-nine chartered steamships of 82,477 tons gross, make together a total of 100 steamships of 269,868 tons gross. Many of the United Fruit Company's steamers are fitted with mechanical cooling on a system adapted from the J. and E. Hall system used on Messrs. Elders and Fyffes' steamers, but modified to suit the special conditions of the American trade ; some are fitted with the regular Hall installation, and others with Hall's machines of exceptional power to deal with fruit of a riper grade, which will go into consumption as fast as it can be put on the market.

The chief sources of supply to the United States are the following countries : Jamaica, Costa Rica, Colombia, Panama, Guatemala, Nicaragua, Honduras, Cuba, San Domingo. The total number of bunches of bananas imported into the United States from all sources for the year ended September 30, 1912, was as follows :

United Fruit Company	.	.	.	26,974,258
Other companies	.	.	.	16,287,411
				<hr/>
Total	.	.	.	43,261,669

The estimated shipments of bunches of bananas to the United States for the year ended September 30, 1913, are

United Fruit Company	.	.	.	29,842,135
Other companies	.	.	.	17,035,000
				<hr/>
Total	.	.	.	46,877,135

The growth of the demand for bananas necessitates continued extensive development work. Large purchases by the United Fruit Company of banana properties and lands available for banana planting were made during the year 1912 in the Republics of Colombia, Panama, Costa Rica, and in other parts of Central America. Large developments are being carried on in Costa Rica, Guatemala, and Panama, the company's policy being to grow a large proportion of its fruit in order to ensure an adequate supply and maintain a standard quality.

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In order to show how enlightened and advanced the general policy of a large company must be if they intend to command success, reference may be made to the Medical Department of the United Fruit Company. Since its organization it has maintained hospitals at various places for the care of its employés, and it has created a department to have charge of these hospitals and of sanitary work at the tropical divisions, and of the medical staff upon the steamships, and the supervision of quarantine matters. The activities of this department involve an outlay of several hundred thousand dollars annually. As a result, in large measure, of its work, the localities in which the company operates have been relatively free from dangerous contagions, and mutually helpful relations are maintained with Government health and quarantine authorities.

In order to give some idea of the extensive operations of the United Fruit Company, the following table is given for the year ended September 1912 :

—	Number of Acres			Miles of Road Owned		Miles of Railway Operated
	Owned	Leased	Under Bananas	Railways	Tramways	
Colombia .	72,302	10	17,169	11.46	18.04	—
Costa Rica .	191,664	5,933	26,768	{ 77.05 135.39 }	158.64	163.21
Cuba .	91,894	—	203	103.90	—	—
Guatemala .	110,532	—	22,156	27.90	66.10	—
Honduras .	28,471	245	6,163	16.55	—	—
Jamaica .	34,081	26,250	8,052	15.20	8.58	—
Nicaragua .	193,000	—	—	—	—	—
Panama .	98,178	—	34,949	225.81	54.53	—

Atlantic Fruit Company.—The prosperity of the Boston Fruit Company and the United Fruit Company which absorbed it brought many imitators into the banana field, one of the most successful of which has been the Atlantic Fruit Company. This concern was originally formed by Mr. Joseph Di Georgio in Baltimore in 1901 as the Di

Georgio Importing and Steamship Company, and in its infancy its operations were confined to the purchase of bananas in the open market in Jamaica, where they loaded one steamer per week carrying about 12,000 bunches. From this small beginning the company has gradually grown and become one of the largest growers of bananas doing business in the tropics, at the present time chartering twenty-two steamers plying from the ports of Port Antonio in Jamaica ; Bluefields and Pearl Lagoon, Nicaragua ; Puerto Cortez, Honduras ; Frontera, Mexico ; Sama and Sagua de Tanamo, Cuba ; and Santa Marta in Colombia, to the New York, Boston, Philadelphia, Baltimore, and New Orleans divisions of the company in the United States. The company imported during the year 1912 7,135,488 bunches of bananas.

In 1905 Mr. Di Georgio, wishing to enter into a larger field, organized and incorporated the Atlantic Fruit Company under the laws of the State of Delaware ; and it was reorganized in 1911 under the name of the Atlantic Fruit and Steamship Company, acquiring 196,000 acres of land in Nicaragua and about 35,000 acres in Cuba, besides securing long-term leases on about 35,000 acres of banana land in Jamaica. The tonnage grew to such an extent that the company entered into an agreement with the Hamburg-American Line to take care of part of their tonnage. In January 1913 additional foreign interests were taken into the company, and the Atlantic Fruit Company was formed to take over the business of the Atlantic Fruit and Steamship Company.

Exports from Plantations—A Variable Amount.—The number of bunches exported from each country differs from year to year, the amount being dependent on various conditions of climate, such as drought and heavy winds. For instance, the quantities exported to all sources from Jamaica were in the year 1907, 16 millions ; in 1908, 14 millions ; in 1909, $16\frac{3}{4}$ millions ; in 1910, they fell to 14 millions, and in 1911 rose again to $16\frac{1}{2}$ millions. The exports of bananas from Costa Rica were a little over

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10 million bunches in 1908, but they fell in 1909 to 9,365,690 bunches, in 1910 to 9,097,285, and in 1911 rose to 9,309,586. But on the whole, as the demand steadily increases, so do the number of acres planted and the number of bunches exported. In Costa Rica the area under bananas in 1910 was 62,500 acres, and new plantations amounting to 2500 acres were made in 1911; in Jamaica in 1911-12 the area was 82,435 acres, the average for the previous four years being 67,573 acres. The Canary Islands appear for the present to have come to about the limit of cultivable land for bananas, and the production therefore cannot increase very much until new irrigation canals are made. The output from Costa Rica for the year 1912 was estimated at $10\frac{1}{2}$ millions, from Santa Marta in Colombia over 6 millions, and from Bocas del Toro in Panama $5\frac{1}{2}$ millions.

The United States Consul at Port Antonio, Jamaica, writes as follows :* “ Notwithstanding the increased acreage in bananas, the Jamaican crop for 1912 shows a considerable decrease in consequence of an unusually protracted drought, and the crop has been further damaged by hurricanes which swept the island on November 17 and 18. The injury to the banana crop in this consular district, embracing the parishes of Portland and St. Mary, will probably cause a decrease of about 1,000,000 bunches, and there will be a loss in the whole island estimated at 3,500,000 to 4,000,000 bunches, chiefly in the yield of next year. Where plantations have been entirely devastated, they will yield little fruit for export next year, for the reason that it will be more profitable to plan for a spring crop in 1914, when the prices will be high, than for a crop in the fall or winter, the seasons when prices are generally lowest. As the loss in Jamaica will probably be more than offset by gains in Colombia, Panama, Guatemala, and other countries which have been steadily increasing the acreage in this crop, a small advance in the world's production for the current year may still be expected. The

* “United States Daily Consular and Trade Reports,” December 26, 1912.

consumption of bananas in manufacturing food products, an industry which has assumed considerable importance in Jamaica, will be checked for some time owing to the destruction of fruit by the recent storms and hurricane."

A severe wind storm occurred on April 10, 1913, at Santa Marta, Colombia, and it is estimated that 750,000 banana plants were blown down, resulting in a loss to the United Fruit Company of about £200,000.

Development in England.—The distance of sources of supply from England, except the Canary Islands, was unfavourable to the early development of the trade. Messrs. Fyffe, Hudson, and Co. and Messrs. Elder, Dempster, and Co. were importing the small Chinese banana from the Canary Islands into England, packed in crates, and for some years this was the sole source of supply. In 1884 the total importation into England was about 10,000 bunches. But in 1901 the Imperial Direct Line between Bristol and Jamaica was started by the late Sir Alfred Jones, Chairman of the Elder-Dempster Lines, a subsidy of £20,000 a year for ten years being granted by the Imperial Government, and an equal amount being contributed by the Jamaican Government. The steamers took a cargo of at least 25,000 bunches once a fortnight, and were specially fitted with the cooling apparatus invented and manufactured by Messrs. J. and E. Hall, of Dartford.

On the initiation of the Imperial Direct West India Mail service by Messrs. Elder, Dempster and Co., a separate company was formed, with Sir Alfred Jones as Chairman, to undertake those obligations of the Government contract which referred to the buying of fruit, but before long it became evident that the basis of supply must be widened, and the new company, being combined with an old-established firm of fruit importers under the title of Elders and Fyffes, Ltd., purchased four vessels, installed Messrs. Hall's plant on them, and instituted regular sailings between Costa Rica and Manchester and Bristol. In each of three subsequent successive years the company brought out three steamers of a very fine type.

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Messrs. Elders and Fyffes' fleet now numbers sixteen large vessels, all similarly fitted, and having an aggregate cooling capacity of about 1,000,000 bunches.

The imports of bananas into the United Kingdom were about 10,000 bunches in 1884, 1,500,000 bunches in 1901, while for 1912 (to September 30) the total amounted to 6,833,625 bunches, imported from different countries as follows :

Elders and Fyffes :

From Costa Rica	.	.	2,481,855
„ Colombia	.	.	2,709,137
„ Jamaica	.	.	150,678
„ Canary Islands	.	.	638,552

Other companies :

From Canary Islands	.	.	853,403
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Messrs. Elders and Fyffes have established large depots and stores in the majority of the large towns in the United Kingdom, from which they supply small retailers not only in large towns but in many remote villages.

A few words must be said here about some other steamship lines carrying bananas.

The Royal Mail Steam Packet Company have (a) a steamer arriving in London every fortnight bringing as part of her cargo bananas from the Canary Islands. This being only a short passage, no arrangements of an artificial character are made for preserving the fruit on the voyage. (b) A mail steamer arrives at Southampton every fortnight which brings, amongst other cargo, bananas from the West Indian Islands. Some of these steamers are fitted with chambers kept cool and fresh by a system of fans and airshafts. Others have insulated and refrigerated holds wherein the fruit is stowed at a suitable temperature. (c) The steamers mentioned in (b) in the course of their voyages also carry bananas in considerable quantities from Jamaica to New York.

The Atlas Line of the Hamburg-Amerika Linie have at present eight ships occupied in carrying bananas from the West Indies to New York. These steamers carry between 25,000 and 35,000 bunches each, and two steamers are about to be replaced by larger steamers carrying about 50,000 bunches each. In all, therefore, they are able to transport between 250,000 and 280,000 bunches per month, the steamers making one round trip every four weeks. They have not begun yet to carry bananas from the West Indies to Europe.

The Compagnie Générale Transatlantique have no steamers specially built for carrying bananas, but, on the Havre-Bordeaux-Colon Line, the steamers, which are provided with cool chambers, call on the return journey for bananas at Martinique and Guadeloupe.

The Pacific Steam Navigation Company carry bananas by steamers calling homewards from Las Palmas, Canary Islands. There is a regular fortnightly mail service, and a fortnightly intermediate service. Two hundred crates are taken once a month to Havre. Bananas are also carried to London, Swansea, and Liverpool by steamers going direct from Las Palmas to one of these ports.

The Shaw, Savill, and Albion Company carry bananas from the Canary Islands as a small adjunct to their trade between New Zealand and England. All their steamers homeward bound call at Teneriffe on their way to London, and almost all take some bananas on board. The quantity by each steamer is very variable, being fairly large at the height of the banana season. The fruit is carried for the most part on deck and arrives in good condition.

The New Zealand Shipping Company have mail steamers calling at Teneriffe every four weeks, and cargo steamers about every three weeks, which bring to London crates of bananas varying in quantity from 1000 to 10,000 crates according to the season. They are carried chiefly on deck or in shelter deck spaces on deck.

The steamers of the Union-Castle Line carry bananas

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from the Canary Islands to London and occasionally to Southampton. The steamers call alternately at Las Palmas and Teneriffe, a fortnightly service being maintained.

The Nelson Line have a weekly service of steamers from the River Plate to London, calling at Las Palmas, where shipments of bananas are obtained according to the season. There are ten steamers, ranging in gross tonnage from 7381 to 7634, or 4659 to 4824 registered tonnage. There is also a fortnightly service from the River Plate to Liverpool, calling at Las Palmas for bananas under similar conditions. There are seven steamers on this route, ranging in gross tonnage from 4128 to 6027, in registered tonnage from 2653 to 3835.

The Elder-Dempster Company's steamers returning from Africa call on an average once a week at Teneriffe and twice a week at Las Palmas. From Teneriffe they have carried in a year 300,000 crates, or an average of 5555 crates per steamer; from Las Palmas 400,000 crates, or an average of 4300 crates per steamer: total for twelve months, 700,000 crates, to Liverpool. The steamers are not insulated, but the fruit is invariably landed in excellent condition, especially from those steamers having sheltered deck accommodation.

Besides these companies, the following also carry bananas from the Canary Islands:

For London or Liverpool or for both ports—Yeoward Bros., R. P. Houston and Co., Otto Thoresen, J. T. Rennie and Son, Bullard, King, and Co., Lampert and Holt, Houlder Bros., Harrison Line, G. Thompson and Co., David McIver and Co., Bucknall S.S. Co.

For Hamburg—Hamburg-Bremen-Afrika Linie, Hamburg and South American S.S. Co., Deutsche Ost Afrika Linie, Woermann Linie, Kosmos Linie.

For Marseilles—Société Générale de Transports Maritimes, Cyprien Fabre.

For Cadiz and Barcelona—Compania Transatlantica; Pinilles, Izquierde, and Co.

For Genoa—Lloyd Sabaude, Ligure Brasiliana, La Veloce.

For Trieste—Unione Austriaca de Nav.

Development in Europe.—The total number of bunches exported for the year ended September 30, 1912, from the Canary Islands to all parts was nearly $2\frac{3}{4}$ millions, of which nearly $1\frac{1}{2}$ millions went to England, while the rest was divided up between Germany, France, Italy, and a fair proportion went to Egypt during the winter months. Germany takes a large proportion. France is taking at present 2500 bunches of West Indian bananas weekly, via Liverpool and Dunkirk, and this trade only commenced at the end of the year 1911. The rest of the bananas sold in France all come from the Canary Islands. The consumption of bananas on the continent of Europe is increasing fast, although most of the countries protect their native fruits by means of an import duty. For instance, in 1877 only 5000 bunches of bananas were imported into France; this rose in 1901 to 50,000 bunches, and in 1904 to 250,000 bunches. The bananas sold in the South of France and in Algeria under the name of Dahomey bananas, as a rule all come from the Canaries.

The export trade from England to the Continent is being rapidly developed; the total shipments from England to the Continent for the year ended September 30, 1912, were 1,023,641 bunches. One thousand bunches are sent every week to St. Petersburg, although the import duty into Russia is £11 18s. a ton; 1200 bunches a week go to Sweden, duty £5 10s. a ton; 2000 to Norway, duty £1 2s. a ton; 1000 to Copenhagen, duty 11s. a ton; 8000 to 9000 to Germany, some being from the Canary Islands, duty nil; 3000 to 4000 to Holland, duty 5 per cent. on invoice value, plus 5s. duty on vans; 2500 West Indian bananas to France, via Liverpool and Dunkirk, duty £2 13s. 4d. a ton plus octroi duties, besides some from the Canary Islands.

The increase in the importation of bananas into Hamburg is given in the table on p. 165 (from "Les Bananiers," by

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Dr. E. de Wildeman, 1913) to the year 1909. The figures are numbers of dozens of the fresh fruit, and those for 1912 are only approximate :

—	1895	1905	1906	1908	1909	1912
Canary Islands	130	18,952	29,575	65,444	121,345	10,500,000
Madeira . .	271	917	264	—	—	—
West Indies and Central America }	—	—	590	27,208	34,359	1,895,000
Cameroon . .	—	—	—	165	82	—
England . .	—	—	1,370	6,388	11,721	2,980,000
Holland . .	—	—	75	57	—	—

CHAPTER XXI

TRANSPORT BY SEA

Carriage by Steamers.—It is of the first importance that the least possible time should elapse between the cutting of the fruit and its sale to customers. Messrs. Elders and Fyffes have now specially constructed steamers of 5000 tons capacity, each capable of carrying 60,000 bunches; they are fitted with the latest cool-air system, which ensures an even temperature of about 56° F. (13° C.), and there is a weekly sailing.

It is difficult to realize the amount of attention and care that is necessary to bring the fruit in perfect condition to the retailer. After the vessel is docked, the first step is to lift, by means of crane-power, enormous cages filled with bananas, which occupy the space of the hatchway area from the upper to the bottom deck. After these cages are removed the hatchway is clear, and it is then possible to start discharging the fruit by means of elevators from any one of the four or five decks, as may be found expedient. The steamers are fitted with loading and unloading machines working on the principle of endless belts. It takes from 250 to 400 men to unload a steamer—a task which is invariably accomplished in one day. A cargo is the equivalent of about 500 railway truck-loads. Owing to the delicate nature of the fruit and the risk of chill, it is a matter of the greatest importance that it should reach its destination on the day following that of its despatch.

At New Orleans * and Mobile the United Fruit Company employ motor-driven machines of the marine leg type to unload bunches of bananas from the holds of their vessels,

* *Times Engineering Supplement*, August 16, 1911, p. 19.

thus saving much time and labour as well as the damage to the fruit that was formerly caused by hand unloading. A 35 ft. vertical marine leg drops from an extension projecting over the water's edge into the hold of the vessel drawn up to the wharf. Sprocket wheels on the marine leg and the stationary portions of the unloader carry a pair of chains 4 ft. apart, between which on cross-bars is attached a canvas strip so arranged with slack as to form pockets at 3 ft. intervals. Each of the four machines at New Orleans has ninety-two pockets, and they are driven by individual 15 h.p. induction motors. They are able to unload 2500 bunches of bananas an hour, the bunches weighing from 60 lbs. to 120 lbs. each. In the hold of the vessel the conveyers are filled from three levels, each level loading into every third pocket of the conveyer, the speed of which is too high to permit succession pockets to be filled from a single position.

After reaching the dock end of the conveyer the pocket chain passes over a flat roller, which gently discharges the fruit upon a moving belt running back to the cars, where it is loaded for shipment by rail. At this point the Mississippi River has a periodical variation of 14 ft., and the unloaders must accommodate themselves to this variation as well as reach the hatches of any ordinary vessel. The marine leg is supported from an auxiliary boom hinged to the main boom, so that by making a jack-knife bend, practically any hatch level or distance from the wharf can be negotiated. The manipulation of the booms and the hoists and the side travel of the hinge machine along the deck are controlled by friction clutches on the main conveyer motor shaft. Within three to five minutes after the vessel's hatches are made ready, the machines can be placed in position and the unloading begun. Ships can be unloaded in from ninety minutes to seven hours, according to the size of their cargo.

Refrigeration in Sea Transport.—Mr. H. J. Ward, a director of Messrs. J. and E. Hall, Ltd., Dartford, has supplied the following information on this subject, which

was originally prepared for, and read at, the "Premier Congrès International du Froid," in Paris in 1908.

When Sir Alfred Jones, Chairman of the Elder-Dempster Lines, undertook the contract for a line of fruit steamers to Jamaica, he recognized that by the aid of cooled air alone could the contract requirements be met, and entrusted Messrs. J. and E. Hall with the designing and supplying of complete refrigerating installations for the new vessels.

The system adopted was generally on the lines of the successful installations designed and carried out during the previous few years by Messrs. Hall for the transport of apples on a number of vessels employed in the Australian trade, but the much more critical condition of bananas on shipment and the great quantity of gas and heat given off in the very rapid ripening of this fruit had to be estimated and allowed for. That the pioneer vessels continued carrying and landing their fruit in first-class condition, and that, except in some trifling details, the fruit-carrying arrangements are exactly as they were when first installed, is conclusive evidence that the assumptions then

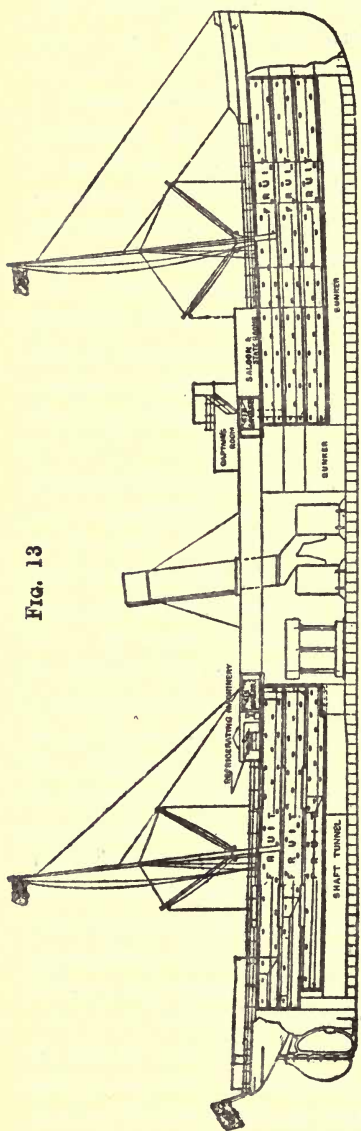


FIG. 13

made were not far wrong. In fact, a description of the latest vessel put in the service applies to the earliest, the only modifications having been in details, *e.g.* the air fans are now coupled to electric motors instead of high-speed steam engines.

Fig. 13 shows in elevation the general arrangement of Messrs. Elders and Fyffes' S.S. *Barranca*—one of a class of fine steamers designed exclusively for banana carrying, and recently added to their fleet. The refrigerating machinery and cooling appliances are in deck-houses on the upper deck, thus leaving the spaces below as clear as possible for the cargo. There are three decks of fruit forward and aft respectively, and each deck has a clear run of about 130 ft. between bulkheads, making six fine chambers, each taking about 10,000 large bunches, the total of nearly 60,000 bunches being about three times the number carried by the steamer *Port Morant*, which initiated the service in 1901.

The fruit comes on board within a few hours of cutting, and is stowed without covering of any kind, the lowest bunches being arranged with the stems vertical, with a final layer placed horizontally, this giving the best results both in utilizing space and freedom from damage. Every cargo space is divided into bins by portable horizontal sparring fitting into vertical posts, thus checking the movement of the fruit in rough weather. Sparred gratings are laid on the steel decks to carry the fruit clear of the plating, and to allow the air to circulate below and up through the fruit. The ship's sides and bulkheads and the highest and lowest decks are insulated with granulated cork and wood boardings, forming a complete envelope about 7 in. (say, 18 centimetres) thick. Along each side trunks conveying the cooled air are formed by boardings, in which are a number of openings fitted with adjustable slides, and spaced at suitable intervals and levels.

Powerful fans of the centrifugal type, arranged in pairs and coupled to electric motors, draw the air from the fruit chambers through the suction trunks on one side, pass it

over closely nested brine piping, thereby cooling and drying it, and returning it through the delivery trunks on the opposite side. The cooler pipes are electrically welded into grid form, there being no screwed joints except those on the headers, the brine flow being regulated by valves controlling a number of separate groups of grids. The cooling surface is properly proportioned to the work to be done, and the cooler with its fans is completely insulated. Ventilators are provided, enabling the air in the fruit spaces to be changed in as few minutes as may be found desirable from time to time, the fresh air passing through the cooler before reaching the fruit, and the vitiated air being discharged to the atmosphere. The brine is cooled by a large horizontal duplex CO_2 machine of J. and E. Hall's standard design, with compound surface condensing steam engine, the CO_2 condenser coils (of copper) being contained in the base, and the evaporator coils in a separate D-shaped casing, the two halves of the machine combining two complete units capable of independent working, the steam connexions enabling either cylinder to be worked as a simple engine with the halves of the crank-shaft disconnected. The brine pumps are of the vertical duplex type, two in number, either one capable of performing the full duty in emergency.

The machines and fans are run during the last day or so of the outward voyage to cool down the spaces in readiness to receive the fruit. Stowage is rapid, owing to the use of power-driven conveyers, and discharge even more rapid, some of the fruit in the square of the hatches being stowed in special cribs, which are lifted out by the ship's derricks immediately the hatches are off, leaving space for the discharging elevators, which are promptly lowered into position. During the first two days of the homeward voyage the plant is run continuously to extract the sun heat from the fruit and to retard ripening. The condition of the fruit is kept under close observation, temperatures being taken at regular intervals day and night, the captain, assisted by the ship's officers—all carefully trained men—

personally attending to these duties. After a few days at sea the temperatures are generally well in hand, and care has then to be taken to avoid the risk of chilling, the machine being slowed down, and probably one of the compressors disconnected, just sufficient power being developed to maintain the temperature at about 55° F. The condition of the fruit on discharge will depend to some extent upon the market conditions, and if it is to go into consumption immediately, the temperature may be allowed to rise during the last days of the voyage.

Separate Storage for Bananas.—It has been found by practical experience that bananas and oranges cannot advantageously be sent in the same hold. The Director of Agriculture, Jamaica, in his Annual Report for 1909–10, refers to some experiments made in this connexion as follows :

“Experiments on the gases given off by bananas and oranges, respectively, were carried out at the laboratory. It was shown that oranges gave off a good deal of carbonic acid gas when stored in a closed place, as in a ship’s hold, but, on the other hand, carbonic acid was proved to be a wonderful preservative of bananas. It was shown, however, by direct trial, that the emanations from oranges stored in a chamber were found to have the effect of bringing about a premature ripening of bananas, if these gases were passed through a chamber laden with this fruit. The practical lesson indicated by these experiments is that separate storage is desirable for citrus fruits and bananas, when they are being transported for long distances by sea.”

Methods of Carrying Bananas without Cool Storage.—In the *Journal d’Agriculture Tropicale*, No. 74, reference was made to an account, in the *British and South African Export Gazette*, of a method of transporting bananas without the employment of refrigerating chambers. The investigations mentioned * were undertaken in order to find a cheap way of carrying bananas from South Africa, in view of the expensive nature of cool storage during so long a voyage

* *Agricultural News*, x. 1911.

as that to England. Trials were made by the firm of Messrs. Cockburn, Hemelryck and Co., of London, and consisted in carrying the banana in pulverized peat. The account stated that, after several unsuccessful attempts, satisfactory results were obtained. Experiments had demonstrated the necessity for picking the fruits as soon as they had lost their green appearance, and of packing them in a special kind of peat which had been completely freed from all earthy matter. The preserving action of the peat was stated to consist in its possession of absorbent properties, by which it protects the fruit from external moisture, and from the decay that results from the presence of this.

The issue of the same paper for October 1910 makes reference to the above account, and goes on to describe experiments of a similar nature that have been undertaken recently with bananas from the Cameroons and from Togo. A first consignment in peat, unfortunately, however, containing only five banana fruits among several kilogrammes of fresh kola, was sent in December 1909 from the Cameroons to Hamburg. On arrival, the fruits were found to be in good condition, and remained in this state for several days. Equally satisfactory results have been obtained by the administrator of the plantations of Bibundi, in the Cameroons, who has succeeded in exporting bananas which arrived in good condition for the Hamburg market. It is estimated by one authority that it will be possible to export bananas in peat, on a commercial scale, from the Cameroons and Togo to Hamburg, at a net profit of between $\frac{1}{2}d.$ and $1d.$ per fruit.

The same article finally points out that, according to the *Natal Agricultural Journal* for March 1910, in Natal, where methodical experiments in connexion with the export of bananas have been conducted for several years, it is considered that well-dried maize husks are superior to peat as a medium for transporting bananas to Europe. Consignments of the fruit, large enough to be of commercial importance, made during last season, confirm the results

of the experiments. It seems that the insulating and absorbing qualities of maize husks, together with efficient ventilation of the fruits during the voyage, assure better conditions of transport than those which arise from the employment of cool storage.

CHAPTER XXII

TRANSPORT ON LAND

Carriage by Railway.—The fruit steamers unload now at Garston on the Mersey, instead of on the Manchester Ship Canal. To make full provision for the new service the London and North-Western Railway have expended considerable sums in the building and fitting up of a commodious banana warehouse, including a lofty shed for the reception of Jamaican oranges in season, and a suite of offices to accommodate the whole of the firm's staff. The bananas for the local markets are at once loaded into wagons and despatched by road to their destination; while those for distant markets are packed into railway vans, forming special trains. Liverpool supplies all the districts north of Birmingham, and Bristol those south of Birmingham. Five hundred insulated vans for the carriage of bananas have been built and fitted with the latest appliances, including steam-heating and vacuum-brake pipes, and are used for the transport of the fruit from the steamer's side by rail to certain principal centres. To meet the requirements of the fruit steamers, the railway company have carried out many improvements, not only at the docks, wharves, and railway sidings, but even in the sea-channel. The consignment in the special trucks remains intact until it arrives at its destination.

Method of Distribution.—In order to meet the difficulties of the smaller deliveries, and to put the towns of relatively small population on the most favourable conditions as regards supplies, a system of local centres has been adopted, which is gradually being extended. The fruit is sent to these centres in large consignments,

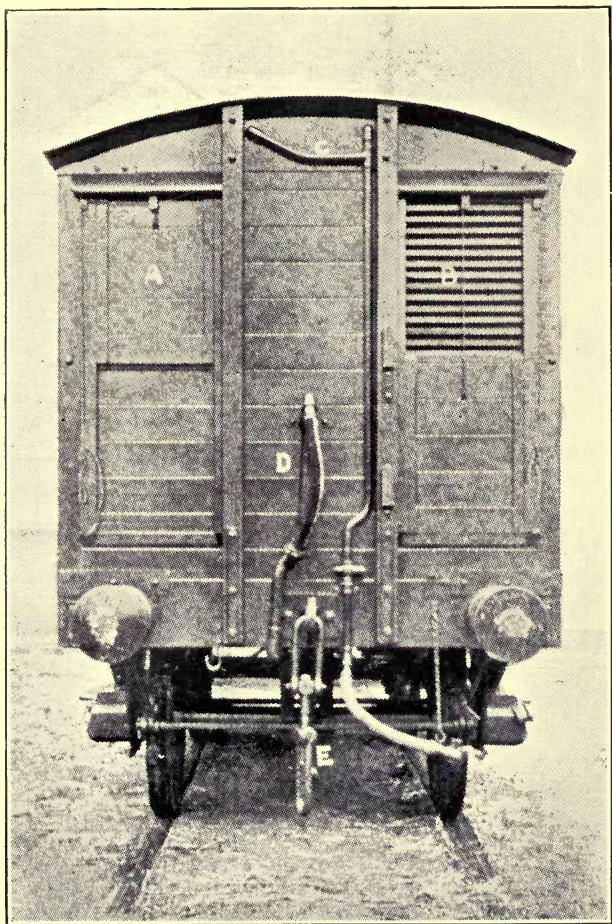


FIG. 14. A SPECIAL RAILWAY TRUCK FOR BANANAS

morning following its discharge from the steamer. A number of light vans are ready to distribute it, diverging along the main roads to a distance of fifteen miles, enabling the smaller towns and the larger villages to obtain their supplies on the best possible terms. Several of the more enterprising railway companies, as well as the London and North-Western Company, realizing the importance of the trade, have built specially fitted trains for the conveyance of bananas, the principal features being steam-heating during the winter months and efficient ventilation for hot weather.

Bananas need careful handling at all times. When knocked about whilst in a green condition, the skin, when ripe, will show black marks, but these in no way affect the fruit. Ripe fruit, on the other hand, that has suffered rough treatment will go pulpy and turn black.

The fruit will only travel properly in the unripe condition, and the retailer has to take care that only such portion of his supply shall ripen each day as he can get rid of. Messrs. Elders and Fyffes publish, for the benefit of the retail merchant, full and detailed directions for the construction of small rooms for the reception of the fruit and for the proper ripening of it, enabling him to handle it successfully, and to ripen it as required for sale from day to day.

In Louisville, Kentucky,* electric radiators are employed to ripen the fruit for local consumption. Formerly gas was employed to heat the air in the ripening compartments, but after a disastrous explosion it was decided to use electric radiators. The ripening rooms comprise two compartments measuring 8 ft. by 10 ft., with 6 ft. 6 in. ceilings, which are separated from the rest of the cellar by double partitions with intermediate air spaces. The bananas are placed on hooks suspended from the ceiling. A resistance type of air heater, consuming from 1200 to 900 watts at its three temperature steps, is placed on a zinc mat on the floor, and keeps the room temperature at

* *Times Engineering Supplement*, August 16, 1911, p. 19.

the desired range of from 60° to 80° F. The ripening process, which requires 48 hours, is assisted by maintaining a temperature of from 75° to 80° F. for that period, and for storing the fruit after it has ripened the temperature should be 60° to 70° F. The three-step switch on the radiator enables this regulation to be made conveniently. During ripening, the bananas give off a good deal of steam and moisture, and the chemical processes that occur in ripening also produce an appreciable quantity of heat. The heater is operated on the middle step continuously except during the very warm summer months, when the ripening process does not require artificial heat. During an average month the heater consumes 495 kw.-hours at a cost of nearly \$24.75 (nearly £5).



FIG. 15. UNLOADING BANANAS AT GARSTON DOCKS, LIVERPOOL
It will be noted that patent elevators are used. These bring the bananas from the bottom hold of the steamer and deliver them on to continuous bands on the wharf, which carry them any distance required

CHAPTER XXIII

GENERAL REVIEW OF THE CULTIVATION OF SPECIES OF MUSA (BANANA AND PLANTAIN) THROUGHOUT THE TROPICS

INDIA AND CEYLON

HAVING considered the natural history, the cultivation, the uses, and the commercial aspects of the banana from experience in a British colony where the fruit is the principal export, and where cultivation and methods of transportation have reached a high state of perfection, it remains to consider briefly the importance in tropical countries generally of bananas and plantains, both for home use and for export.

The Kew *Bulletin* for August 1894 (a mine of information on species and varieties of *Musa*), Dr. de Wildeman's "*Plantes Tropicales*," Watt's "*Dictionary of Economic Products of India*," and other works have been consulted.

A. de Candolle, in the "*Origin of Cultivated Plants*," says: "The antiquity and wild character of the banana in Asia are incontestable facts. There are several Sanskrit names. The Greeks, Latins, and Arabs have mentioned it as a remarkable Indian fruit tree. Pliny speaks of it distinctly. He says that the Greeks of the expedition of Alexander saw it in India, and he quotes the name *pala* which still persists in Malabar. Sages reposed beneath its shade and ate of its fruit. Hence the botanical name *Musa sapientum*. *Musa* is from the Arabic *mouz* or *marwoz*, which we find as early as the thirteenth century in Eba Baithar. The specific name *paradisiaca* comes

from the ridiculous hypothesis which made the banana figure in the story of Eve and of Paradise.

“ There is an immense number of varieties of the banana in the south of Asia, both on the islands and on the continent ; the cultivation of these varieties dates in India, in China, and in the Archipelago from an epoch impossible to realize ; it even spread formerly into the islands of the Pacific and to the west coast of Africa ; lastly, the varieties bore distinct names in the most separate Asiatic languages, such as Chinese, Sanskrit, and Malay. All this indicates great antiquity of culture, consequently a primitive existence in Asia, and a diffusion contemporary with or even anterior to that of human races.”

There is little doubt that the banana and plantain are natives of India and Southern Asia. The cultivation is general all over India except the extreme north-west, from the sea-level up to 5000 or 6000 ft.

In Bengal cultivation is carried on chiefly along the banks of rivers ; the plantain is a farm crop, the banana requiring to be cultivated in gardens with good care and attention. The plantains are planted in fields of rice, cocoes (*Colocasia antiquorum*), or egg plant (*Solanum melongena*), from 12 to 15 ft. apart. No watering is necessary, as planting is done in the rainy season (June and July). Only two shoots are allowed to grow from each plant. When the rice is harvested, a crop of beans can be grown, but no third crop is allowed when plantains are grown in fields of cocoes or egg plant. When these are off the ground, the field is ploughed two or three times. With care and cultivation, a plantain field may be kept up for more than ten years, but no catch-crops are allowed after the first year.

Of bananas, the best is known commonly as the “ table plantain,” and is grown entirely for the use of Europeans and the better class of well-to-do natives ; the fruit is of inferior quality only in the rainy season. The “ champa ” is the next in quality, but not fit to be eaten till it can be removed from the bunch without effort ; stem and mid-

rib of the leaf red, fruit pale straw-coloured, about 6 in. long. Then comes the "Dhakkai," a long pale yellow fruit with light pink, soft pulp (this is probably the variety *Dacca*, distinguished by the pale green leaves and stem white pruinose below, the leaf-stalk having a broad red border).

In the neighbourhood of Calcutta, Firminger ("Gardening for India") mentions the principal varieties cultivated there as follows: "Champa," decidedly the finest of all, rivalling in lusciousness and delicacy the most delicious pear, not fit to eat until it can be removed easily from the bunch. "Chenee champa," similar, but fruit not much larger than a man's thumb; bunches large and densely compact. "Martaban," a delicious fruit resembling the champa, and by some considered equal to it. The plant has no red midrib, but the rim near the base has a slight border of reddish brown. "Daccâe" or "daccâe martaban" has a flavour surprisingly rich and luscious. The plant is recognized by the large quantity of lime-like powder coating the stem and underside of the leaves. The fruit is 4 in. long, with a very thick rind. "Kutch Kela," fruit of large size, used only in its unripe state for curries; when boiled it has somewhat the flavour of the parsnip, and is a nice vegetable with roast meat. "Ram Kela," in good condition a remarkably fine fruit, much resembling in flavour and buttery consistency the daccâe. The stem, stalks, midribs, and flowers of a dark red colour. Fruit about 7 in. long and rather thin. In Calcutta the fruit of the Chinese banana (*M. Cavendishii*) is difficult to obtain in perfection, as it is uneatable till quite ripe, and on its becoming ripe commences almost immediately to decay.

In Bombay the banana and plantain are cultivated chiefly as garden crops. Young shoots are planted at any time of the year, and are manured once in ten or twelve days. The plants are generally removed after they have borne fruit once and fresh shoots substituted. The system of allowing only one shoot from a bulb to bear fruit is

general. This shoot is styled the "daughter," and when it has borne fruit, the plantation is generally destroyed ; but occasionally a "granddaughter" is allowed to grow. After the plantation is abandoned, the ground is generally used for ground nuts, peppers (chillies), and other similar crops. The best of the cultivated varieties are : "Bajapúrí," a long-pointed, three-cornered fruit with thick skin, yellow, and fine-flavoured ; "Sonekale," considered the best, of very superior flavour ; "Raikale," a large fruit with thick red skin, and of delicious flavour ; and "Kúlí," similar to the last, but yellow.

In the North-West Provinces and the Punjab the climate is not so favourable, and the fruit not so good.

In Assam and Burma both bananas and plantains are commonly cultivated, and are an important factor in the food-supply of the people.

In Madras, Shortt describes the cultivation as being carried on chiefly in wet lands, but also in village gardens. The land is first ploughed, and the plants are put into holes dug 1 ft. every way at 10 or 12 ft. apart. For irrigation, the whole surface is covered with water for a day, but great care is then taken to drain off all superfluous water. The land is hoed once a month until the bunch shoots, when it ceases until the fruit is cut. Three months after planting, a manure of wild indigo and dung is hoed in, and this is occasionally repeated. The stools last for three years, or even four years in good soil. As a rule seven or eight bunches are harvested from each stool, worth two rupees, together with small additions from sale of the leaves and stems. One rupee per stool will, as a rule, be sufficient to allow for all expenses, including assessment. As there are from 300 to 400 stools per acre, a net profit is realized in about four years of from 300 to 400 rupees. In garden lands the plants are put in at from 6 to 8 ft. apart, plenty of sheep manure applied, and then thoroughly ploughed. Irrigation is given twice a week, and the soil is hoed once a month during the whole three years. Shortt describes thirteen different cultivated forms. The kind popularly

known as the "guindy" is considered the best banana, and is described as round, small sized, with a very thin rind, luscious, sweet, and of a most delicate flavour. A good bunch may contain over a thousand fruits. It has been said that no one knows what a banana is until he eats a Madras "guindy." The best plantain is a large one called "Monthen."

The central * and northern parts of Travancore have two wet seasons and are therefore suitable for the cultivation of the banana and plantain. It is the plantain which is commonly grown. A well-drained deep, rich, red soil is most suitable, but a good crop is also produced in black soil. About a year before planting, the soil is ploughed frequently and the ground is enclosed with mud walls or fences to protect the crop from cattle. Planting generally takes place between December and February. When the soil is well prepared, pits 3 ft. deep and 3 ft. round are dug 8 ft. apart. To manure the pits, dried leaves are burnt within them, and the ashes are well mixed with loose soil to fill up three-fourths of their depth. This also protects the plants from white ants. The shoots are then planted in the pits and manured with fresh cow-dung. The pits are then filled with earth up to the level of the ground, and covered over with dried leaves to protect them from the sun. The shoots are not watered, but occasional showers help them to strike root and grow. When they make a fair start, they are manured with cow-dung (fresh is preferable) and green leaves. Most of the plantations when established continue to produce fruit for ten or more years, provided the soil is regularly ploughed, weeded, and manured.

The skin is peeled from the plantain, and the pulp is cut into slices and dried in the sun. For infant food the slices are pounded into flour; for adult food the slices are fried in oil or ghee with salt. The fried article is preserved for months in new earthen pots in a cool place. Fibre is extracted from the trunk. Secondary crops are cultivated—

* *Agric. Journ. of India*, v. 252 (1910).

for instance, yams—three sets being planted between two plantains. This kind of cultivation does not exhaust the soil as in the case of cassava, and the cultivator can also grow grain or peas without additional manuring.

In Ceylon, Moon gives a list of forty-seven different kinds of bananas, of which a few are said to be truly wild. The cultivation is almost entirely in the hands of natives, who grow them around their dwellings for shade as well as for fruit. The area under cultivation is said to be not less than 24,000 acres. The best variety is one called "Suaandel" or "Suwandouli."

Dye and Tan.—The ashes of the plant and of the skin of the fruit are used in India in dyeing. The sap contains tannin, and is a fairly permanent, almost black stain on cloth.

Fibre.—The fibre is in common use by the natives for cordage, mats, and to some extent for paper. The dried leaf-stalk is used for tying fences, &c., as a rough kind of twine.

Besides the fruit several other parts are used as food. The flower-clusters of many kinds are cooked and eaten, generally in curries. The flower-stalk before expansion from the centre of the trunk is eaten, and is sold in Calcutta to the amount of half a ton daily; it is prepared for food by boiling; it is also given to cattle together with the bulbs to increase the quantity of milk.

Drying Bananas in India.—A special method of drying bananas is reported from India * which is well worth the attention of those who are interested in the question of the best provision to be made against periodical times of scarcity of food. The dried fruits could also be exported, and all small bunches could be utilized in this way.

A special kind of banana, called "Rajeli," is employed for drying, the fruit of which is about 6 in. long. The suckers are planted in October 6 ft. apart. Water is given twice a week. When the suckers have begun to grow they are manured with castor cake, and a second

* *Agric. Journ. of India*, vi. 289 (1911).

dose is given a month later, at the rate of 3 lbs. per plant. During the following October the fruit is harvested, just when it is "full" but still green. The hands are "put in a store" formed of "cylinders of a bamboo mat 10 ft. by 10 ft. placed vertically. This store is generally in the centre of the house, and thus the entrance of air is prevented as far as possible. On the floor of this improvised storehouse rice-straw is placed, and on it the hands are spread layer by layer." The topmost layer is covered with banana leaves. One store takes about 12,000 to 15,000 fruits. They are put in the store in the morning and are taken out after three days, when the fruit is yellow. The ripe hands are carried in baskets to the prepared ground on the plain outside the village. The ground has been made hard by beating it with a wooden plank and then plastering it with cow-dung and water. A mat, 6 ft. by 8 ft., is spread on the ground. Then the skins are removed, and the fruit is spread on the mat. Some dry the fruit on a platform 10 ft. high. After lying all day in the sun, the fruits are gathered in a heap in the evening before the cold begins, and are left all night covered with dry banana leaves and a mat. This is repeated for three days and three nights, and on the fourth day the fruits are ready for the market, and are wrapped in bundles of a dozen each in banana leaves. The yearly yield at Agashi is estimated at 160 tons, valued at Rs. 27,000.

The United States Consul at Calcutta reported in 1908 that many banana growers in India were giving attention to the question of an export to Great Britain. He writes :

"It is claimed that vessels properly fitted up can reach the Liverpool market from Calcutta in twenty-five days, and that several kinds of fruits, especially the plantain, can be laid down in Liverpool to compete with the West Indian banana, which now monopolizes the English market.

"The native East Indian banana is smaller by half than the fruit grown in Jamaica, Costa Rica, and along the coast lines of Central America, but the former is as rich

in flavour. In fact, it possesses a 'bouquet' all its own, and would, it is believed, become popular at once with European consumers. The East Indian banana, both yellow and red, grows abundantly throughout the southern provinces and the supply could be made practically unlimited. All the Indian needs to learn is how to cut the bunches at the right time, to handle the fruit without bruising, and so that it can be landed in twenty-five days on the English market before it begins to get yellow. The only thing lacking, it is claimed, is the necessary transportation, and this will be forthcoming if encouraged. The fruit is in India and needs a market, and if enough money is raised to back the enterprise, it is believed that India can get her share of the banana trade of Europe and hold it."

CHAPTER XXIV

GENERAL REVIEW OF CULTIVATION—*continued*

MALAY ARCHIPELAGO

RUMPF, or Rumphius (1627–1702), Governor of Amboyna, and author of the “Herbarium Amboynense” (6 vols. folio, Amsterdam, 1741–1755), drew up very careful detailed descriptions of the kinds known to him; some of these are as follows (*pisang* being the Malay word for banana or plantain):

Pisang tando (horn-like): the whole bunch has generally only two or three hands; if the cluster is reduced to a single fruit, the latter becomes exceptionally large.

Pisang djernang (needle banana): the fruit is short, three-angled, and terminating in a long snout, which is crowned with a thread-like appendage (the style), hence the name. The skin adheres to the reddish pulp, which glitters like silver when transversely broken. The bunch is 7 ft. long with 17 hands.

Pisang medji, the dessert banana (*M. mensaria* Rumph.), is “the best of all bananas”; the fruit is 4 to 6 in. long; the pulp is soft, sweet, and scented as if with rose-water.

Pisang raja (*M. regia* Rumph.) is similar to the preceding, but smaller, hardly the length of a finger and an inch thick, smooth, with a thinner skin, and sweeter and more delicious.

Pisang tonkat langit (*M. troglodytarum* L.) has the bunch growing straight upwards. The fruits are small and plump, of a red colour with black stripes; the pulp is golden yellow; the seeds are few, embedded lengthwise, brown and flat. The cone of male flowers is green, sometimes a foot long.

Pisang alphuru: the flower-stalk is peculiar in bearing leaves "two of which are at the base and similar to those of the stem, but shorter and rounder. Then follow other leaves which are small and narrow, and from each of them rises a thick green stalk on which grow a few fruits, of which, however, only a few come to perfection."

Burbidge, in "Gardens of the Sun," writes as follows:

"Last on my list, but by no means least, among the tropical fruits of Eastern gardens, comes the *pisang* or banana, which here is represented by many varieties, which differ in size of fruit, flavour, and other particulars. One of the most common varieties met with in the bazaars is *Pisang maas*, or golden banana, the individual fruits of which are small, but of a bright golden colour and of excellent flavour. One of the most esteemed of all is *Pisang raja*, or King of Bananas, a larger fruit, also of a deep golden colour, the flavour being very luscious. *Pisang hijan*, the green banana, is slender and angular, but the straw-coloured pulp is of a most exquisite flavour, and it is quite a favourite in Singapore, where the *raja* variety is comparatively scarce. *Pisang kling* is a pale yellow kind, bearing large, smooth fruits, and for eating with cheese this is one of the best, being less sweet than those just named. A large horned variety of banana (generally used in a cooked state) is common in Borneo, called by the natives *Pisang tandok*, the individual fruits being 1 ft. long and 2 in. in diameter. The outer skin is green, changing to yellow when fully ripe, and this fruit is liked by those who do not relish the sweeter kinds."

A variety called "King of Thousands" has very numerous fruits on the bunch. A bunch grown in a garden at Singapore, figured in *Gardeners' Chronicle* (December 23, 1911), was about 7 ft. long. The number of fruits must have been well over 2000, and they were closely packed on the stalk. Even when the photograph was taken, the fruiting stalk was continuing to develop and was forming new fruits.

On the experiment station grounds at Kuala Lumpur,

there is a considerable tract of land planted with more than sixty different varieties of bananas. Experiments have been undertaken to determine the value as a food product of banana flour, and the yield per acre.

Junghuhn describes the "wax banana" of Java, the leaves of which are covered on the underside with a minute white powder. The Javanese scrape this meal together, melt it over a fire, and produce a valuable wax. The wax thus obtained becomes very clear, hard, and whitish, and forms an important article of trade in middle Java. Bleaching renders it very white. One banana tree (with seven leaves) yields two ounces of wax. As there are thousands and thousands of plants wild over large areas the preparation of the wax is a remunerative enterprise.

In Borneo the banana is cultivated everywhere up to an altitude of 3000 ft.

CHAPTER XXV

GENERAL REVIEW OF CULTIVATION—*continued*

PHILIPPINE ISLANDS

BLANCO mentions that there are fifty-seven kinds of bananas and plantains known in the Philippine Islands. The most esteemed is "saba-bisco," with a fruit 3 in. long by 1 in. thick; another, the "lacatan," has the fruits crowned with the persistent perianth; a third, the "bungulan," is large, with a sweet pulp.

Fruit.—"Cooked, fried, or raw, the fruit of the banana forms a more important part in the diet of the people than any other fruit; none other figures more prominently in the market at all seasons. It is rather singular that the poorly flavoured and the least desirable varieties are cultivated in preference to the better kinds, though some contend that the reason is that the poorer sorts are hardier. More judicious selection of the varieties grown, together with better cultivation, would greatly increase both the quality and the quantity of the fruit produced. The local markets are well supplied with bananas, but there is ample room for expansion both for the production of fresh fruit for the home market and export, and for the growing of bananas for the manufacture of banana flour, wine, and evaporated fruits." *

Varieties.—Wester and Barrett† note the following varieties as more or less common and important in the order of their enumeration: Lacatan, Latundan, Sabá, Gloria, Bungulan, Butúan, Matabia, Lacatan Morado,

* P. J. Wester, Horticulturist, in *Philipp. Agric. Rev.*, v. 356 (1912).

† *Philipp. Agric. Rev.*, v. 365, 371 (1912).

Daliring Señora, Ni-langon, Tundoc, Chinese Dwarf. They have also noted specimens of an interesting form called "Dominus vobiscum," and consider it doubtful whether it is a constant variety or merely an anomalous form of Sabá. The flower-buds of the banana are extensively used as a vegetable in all parts of the Philippines.

At the Linao Experiment Station experimental work has been carried on for some years with the following named varieties of bananas to test methods of culture and cost of production: Matabia, Lacatan, Gloria, Chinese Dwarf, and Sabá. Six plats of ninety plants each, three of them with thirty additional plants of Chinese Dwarf, were planted as a new plantation on May 31, 1910. The Matabia, from 6 to 8 in. long, 2 in. in diameter, brownish yellow when ripe, has an acid flavour; only used cooked, and may be used as a substitute for apples in pies and puddings. The Lacatan is from 4 to 5 in. long, 1½ in. in diameter, greenish yellow, sweet in flavour, and is said to be the best variety of banana in the Philippines. The Gloria is 4 or 5 in. long, about 1½ in. in diameter, dark yellow, sweet in flavour. The Latundan is the most common variety grown in the island of Luzon; it is from 3 to 5 in. long, about 1½ in. in diameter, bright yellow, acid flavour. The Sabá is from 3 to 4 in. long, about 2 in. in diameter, brownish yellow, no distinct flavour, and is used for cooking only.

Collection of Bananas.—The Bureau of Agriculture, after having made* a preliminary survey and census of the Philippine bananas and plantains, are about to establish as complete a collection as possible of these fruits, "which shall be excelled by none in the world. . . . With the earnest co-operation of Philippine planters and with ordinary success in the line of exchanges with other countries, it is hoped to have 100 varieties growing in this collection within two years."

Manila Hemp.—The species of *Musa* that is most largely cultivated is *Musa textilis*, the source of Manila hemp. It

* *Philipp. Agric. Rev.*, v. 406 (1912).

is distributed throughout most of the islands, and is most successful in those with a heavy and evenly distributed rainfall, between 6° and 15° N., and 121° and 126° E. ; it may be cultivated up to about 4000 ft. above sea-level. It is cultivated in a rude sort of way, solely as a source of fibre. The plants are put out at a distance of from 10 to 12 ft. from one another, and receive little attention except an occasional weeding. Most plantations are provided with trees for the purpose of shading the young plants and protecting them from the violence of the wind. The plant may be propagated by means of seed, but it is usually grown from suckers or bulbs. The plant when mature consists of a stool of twelve to thirty stalks. These stalks are in all stages of development, but usually two to four only can be harvested at the same time. The fibre has attained its highest tensile strength at the period when the flower-bud has just made its appearance at the summit of the plant, which is at the age of two to three years. The trunks are usually then 12 to 14 ft. in height and 10 to 12 in. in diameter at the base, and are two or three years from the time of planting the sucker, or half a year longer from seed. When the flowers mature and the seed begins to ripen, the fibre is dark in colour and inferior in quality.

The trunk is cut up into small strips, which, while fresh, are drawn between a knife-edged instrument and a hard wooden block to which it is fixed. By repeated scraping in this way the soft cellular matter is removed, and the fibre has only to be hung up to dry in the open air, when it is ready for use. Each trunk yields on an average a little under 1 lb. of fibre ; and two natives cutting down plants and separating the fibre will not prepare more than 25 lbs. per day. The yield varies according to the locality in which the plant is grown. In districts which have a heavy and continuous rainfall the yield amounts to 687 to 967 lbs. per acre, but in provinces in which the climate is less humid it may not exceed half this quantity.

A number of machines have been introduced for the

purpose of extracting the fibre economically, but none has come into general use. The greater part of the hemp is prepared on the hill-sides on very rough ground where it is actually growing ; for it has been found most profitable to extract the fibre in the plantations, and so avoid the cost of carriage of the heavy trunks. One of the principal requirements of a decorticating machine, therefore, is lightness and portability, combined with greater efficiency, for the waste caused by the present crude method is estimated at from 20 to 30 per cent.

The exports of Manila hemp have increased very rapidly :

		Tons			Tons
1870	.	31,426	1900	.	89,438
1880	.	50,482	1910	.	160,595
1890	.	67,864	1911	.	146,208

In 1910 the value of the export was £3,432,358, and in 1911 £3,025,036.

This is the largest export, being nearly twice as great as the value of copra and more than twice that of sugar, which come next in value.

The production has been gradually increasing up to the year 1910. The yield for that year was abnormal, and was bound to fall off. The area under cultivation amounted to 1,173,586 acres, and the average yield per acre was 316 lbs. A yield of 880 to 1000 lbs. per acre is considered good, but sometimes as much as 5500 lbs. or more has been obtained. A large number of fields, situated in different districts, were practically exhausted, and had to be replanted with other crops.

CHAPTER XXVI

GENERAL REVIEW OF CULTIVATION—*continued*

AUSTRALIA

QUEENSLAND.—The cultivation of bananas in Australia for commercial purposes is limited to Queensland, and the area * devoted to it there is relatively small, viz. 5198 acres in 1910, which yielded 1,121,075 bunches, averaging 217 bunches per acre. There is, however, an immense area suitable for this culture, much of which is at present in a state of nature. Only the more accessible lands have been planted, and of these only the richest. From the earliest times in the colony the banana has been grown, first in the neighbourhood of Brisbane, then gradually in the settlements as they spread northwards, until it is now found where the wild bananas are indigenous, in all the scrubs of the northern coast, and especially in the rich scrub lands surrounding Cairns, Innisfail, and the Tully River, where soil, climate, and rainfall are all conducive to the production of fine fruit. It is stated that in the coast lands of Southern Queensland no deterioration in the quantity, quality, and size of the fruit has been noticed, but the reverse, although bananas have been grown on the same land for many years. No more convincing proof is needed of the adaptability of this district for the successful cultivation of bananas.

Until quite lately the cultivation in Northern Queensland has not been altogether on right lines, and owners of the land there are beginning to find out that the old

* See papers by Mr. A. J. Boyd and others in the *Queensland Agric. Journ.*

methods are not the best. It has been the custom to rent out the standing scrubs with their wonderfully rich fertile soil to Chinese gardeners, who cleared the land, planted it with bananas, took all they could out of the soil, and then gave it back and rented fresh land. The land was certainly cleared for the owners, but required manuring at considerable expense to fit it again for bananas. The white growers of Southern Queensland have shown splendid results under conditions not altogether so favourable as those in the north, and there is no good reason why banana cultivation should not be now run on proper lines in the north as well as in the south.

The native species of *Musa* (for descriptions of which see Chapter XXXIV) grow in the rich scrub land already mentioned and in all the scrubs of the northern coast. The fruit of these wild bananas contains scarcely any edible flesh; the leathery skin encloses a large number of black seeds. The kinds cultivated are chiefly the Chinese banana (*M. Cavendishii*), and to a less extent the sugar banana and the Lady's Finger. The Gros Michel or Jamaican banana was first introduced from Jamaica in August 1910. The Jamaican banana is also called the Fiji banana, as the fruit is exported from Fiji to the southern States of the Commonwealth in considerable quantities, and is in greater favour there than the Chinese banana, as it travels so much better, and for this reason it has been introduced into Queensland. According to the *Financier*, "the important and profitable industry of banana-growing has received a considerable stimulus in Queensland by the importation of the Gros Michel variety from Jamaica. Its fine flavour, large size, and vigorous growth commend it to the judgment both of the consumer and grower, while the good prices obtained render it an eminently satisfactory crop to the producer. The fruit is of splendid appearance, ripening to a good yellow colour, and is very popular in the Australian markets, selling at from 1s. to 1s. 6d. per dozen retail. Growers of bananas aver that this industry gives much larger returns than any of the older industries when the

best volcanic land is treated. The first cost of getting the land cleared, cultivated, and ready for planting out is very heavy, ranging up to £20 per acre, but in some cases sugarcane land is being dealt with at but little cost. The trees come into bearing in about eighteen months, and then bear continuously."

"Bananas do best," according to the *Queensland Agricultural Journal*, "on rich scrub soil, and it is no detriment to their growth if it is more or less covered with stones, so long as there is sufficient soil to set the young plants. Bananas are frequently the first crop planted in newly burnt-off scrub land, as they do not require any special preparation of such land; and the large amount of ash and partially burnt and decomposed vegetable mould provide an ample supply of food for their use. They can, moreover, be grown successfully on land that has been under cultivation for many years, provided that the soil is rich enough naturally, or its fertility is maintained by judicious green and other manuring. In newly burnt-off scrub land all that is necessary is to dig holes 15 to 18 in. in diameter and about 2 ft. deep, plant the suckers, and partly fill in the hole with good top soil. Small-growing kinds, such as the Chinese, are planted at from 12 to 15 ft. apart each way; but large-growing bananas, such as the sugar and Lady's Finger, as well as the plantains, require from 20 to 25 ft. apart each way."

The best means of maintaining the fertility of banana lands has been the subject of careful scientific investigation, for an account of which see Chapter XII. The Kalisyndicat of Berlin has published at the agricultural offices of the Potash Syndicate in Sydney, New South Wales, a pamphlet on the manuring of bananas by Mr. J. M. Hattrick, who quotes the results of experiments in Queensland and Fiji, which, he maintains, establish that "banana plantations need not be abandoned, but by suitable cultivation and manuring may be maintained indefinitely in highly profitable production."

The bulk of the Chinese bananas produced in the north

is exported to the southern States of the Commonwealth. The industry supports a large number of persons other than the actual producers of the fruit, and forms one of the principal exports from the north. As many as 20,000 or more large bunches frequently leave by a single steamer for the south, and the bringing of this quantity to the port of shipment gives employment to a number of men on tram lines and small coastal steamers. The inspectors under the Diseases in Plants Act are kept very busy, as they have to examine every bunch carefully before shipment to prevent as far as possible the condemnation and destruction of possibly a whole shipment on arrival at Sydney or Melbourne on the assumption that if a few bunches are found affected by fruit fly or any other disease, the whole shipment must be diseased.

“ Many of the bananas are shipped in crates from North Queensland, especially from Innisfail (Geraldton), and from places where the fruit is first loaded on to small river steamers and junks to be transhipped at Cairns. If bunches are sent uncrated from these centres, they are liable to receive much damage from over-handling. The crates are made of roughly split silky oak timber, and the bunches are secured from knocking about by being packed in dry banana leaves. Crate-packed bananas always arrive in better order than loose bunches, as they escape the enormous pressure of the mass of fruit, and, furthermore, receive no more handling until they reach the consignee at the port to which they are forwarded.” (*Queensland Agricultural Journal*.)

CHAPTER XXVII

GENERAL REVIEW OF CULTIVATION—*continued*

POLYNESIA

Fiji.—“ A great many different kinds of *Musa* were found established in different parts of tropical Polynesia, when Europeans first became familiar with them. In Tahiti alone, Banks and Solander saw twenty-eight. . . . Bananas and plantains are known in Fiji by the collective name of ‘Vudi.’ There are about eighteen different kinds, all of which bear distinctive names. With the exception of one, the ‘Soaga,’ none are found wild ; and even this wild one is occasionally met with in plantations. It grows spontaneously in the depth of the forests, often in ravines, and is distinguished from all congeners by its bunch, instead of hanging down, being perfectly upright and presenting a dense collection of orange-coloured fruits (*Musa fehi*). An important addition to their stock of bananas the Fijians received in ‘Vudi ni papalagi’ (*i.e.* foreign banana).” *

The dwarf Chinese banana (*M. Cavendishii*) has proved of such immense importance to Fiji and other islands in Polynesia, that the history of its introduction there is worth recording. Mr. Charles Telfair was the first to obtain plants of this species in 1826 from its native country, Southern China, for his collection of *Musæ* in Mauritius. He considered it to be the most valuable of all the kinds in his extensive collection. “ As it fruited profusely and only grew three feet high,” he thought that it would be a great acquisition to the stoves of this country and accordingly sent two plants of it to his friend Mr

* “Flora Vitiensis.” B. Seemann. 1865-73.

Barclay, of Burryhill, in 1829. On Mr. Barclay's death, one of these two plants was purchased by the Duke of Devonshire, and was grown and propagated at Chatsworth, where it flowered under Paxton's care in November 1836. Mr. A. B. Lambert in the same month exhibited at a meeting of the Linnean Society a copy of an old Chinese drawing which, he believed, referred to the same species, and named it *Musa Cavendishii*. Paxton, in the *Magazine of Botany* for 1837 (p. 51), gives a coloured plate and a description of the Chatsworth plant, and adopted Lambert's name. John Williams, "the martyr of Eromanga," brought suckers of this plant from Chatsworth to Samoa, whence again, in 1848, the Rev. Geo. Pritchard carried it to the Friendly Islands as well as to Fiji. "Its introduction," according to Seemann, "has put an effectual stop to those famines which previously to this event were occasionally experienced in some of these islands. Never attaining any greater height than six feet, and being of robust growth, this banana is but little affected by the violent winds which damage the taller kinds, and this advantage coupled with its abundant yield and the fine flavour of its fruit have induced the natives to propagate it to such an extent that, notwithstanding its comparatively recent introduction, the 'Vudi ni papalagi' numbers amongst the most common bananas of the country. The fruit of the different Musas is variously prepared by the native cooks. Split in half, and filled with grated coco-nut and sugar-cane, bananas make a favourite pudding, which, on account of its goodness and rich sauce of coco-nut milk, has found its way even into the kitchen of the white settlers. The fresh Musa leaves are used as substitutes for plates and dishes in serving food, or for making temporary clothing; the dry leaves instead of paper for cigarettes. In place of the finger-glasses handed round at our tables after dinner, Fijians of rank are supplied with portions of the leaf-stalk of the plantain—not a superfluous luxury in a country where forks are dispensed with except at cannibal feasts."

In 1891 two wardian cases of suckers of the Gros Michel

or Martinique banana were sent from Jamaica to Kew for transmission to Fiji, and these were soon established there.

"The cultivation of bananas," according to the "Handbook to Fiji" (1908), "is being carried on to a considerable extent in the colony, and promises to assume large proportions in the future. Bananas are exported to the Commonwealth of Australia and New Zealand. There are two kinds grown for export—the Gros Michel or Jamaican banana and the dwarf Chinese banana. Most of the estates are situated near the sea-coast or on the banks of rivers. Transport from plantation to steamer is by water. Fiji possesses enormous areas of land suitable for growing bananas; and its splendid geographical position and the fact that it is a port of call for steamers bound to Canada make it unlikely that the supply will exceed the demand if all the markets within reach are tapped. The distance from Fiji to Vancouver, as also that to San Francisco, is not greater than that from the West Indies to England, where an immense trade is being successfully carried on in fruit; and, provided the fruit were available, there is every reason to believe that the shipping facilities would keep pace with any reasonable increase in the amount of fruit grown. The cost of bringing a banana estate into bearing depends on a variety of circumstances. Land which is usually taken up for banana planting is not heavy forest land, but covered with scrub. It is not necessary to stump or plough for the first year or two, the stumps being left to rot in the ground and the banana planted in between. The first crop is obtained in twelve months from the time of planting with the Chinese banana, and in eighteen months with the Gros Michel, and the yield in bunches from good land should be about equal to two-thirds of the number of roots planted. The ratooning crops continue for some years, according to the quality of the land. The average price obtained f.o.b. steamer in Fiji may be said to be 1s. 6d. per bunch of eight hands. The smaller bunches are broken up and packed in cases, which are usually worth from 4s. to 6s. per case. It is

generally conceded that one labourer (coloured) to six acres is sufficient for clearing, planting, weeding, and harvesting ; and the cost per head of such labour is £26 per annum, which includes recruiting, fees, wages, and food. A rough estimate of the cost of opening and bringing into bearing fifty acres of bananas is as follows :

	£	s.	d.
50 acres of land, say 10s. per acre rent	25	0	0
Nine men for fifteen months—£26 per annum	292	10	0
Plants, say	40	0	0
Tools, spades, hoes, knives, punts, and labour house	100	0	0
	<hr/>		
	457	10	0

“ The first crop should give 200 bunches per acre, equal to—

10,000 bunches at, say, 1s. 6d. £750 0 0

“ This is a very low estimate of returns, and it is safe to say that in many instances considerably greater profits are made. In the case of good land, cleared, ploughed, and kept in first-class condition, the cost of upkeep could be reduced and the output increased.

“ The cultivation is one that should be carried on in conjunction with permanent crops, such as cocoa, coffee, spice, rubber, citrus fruits, &c., any of which can be planted in the same lines alternately with bananas ; and in a few years, when the banana crop is exhausted, the ground will be occupied with a permanent crop, the cost of establishing which would be trifling owing to the profit on the bananas, which not only do not injure other crops growing with them, but are of assistance in affording shade and keeping the soil in good condition.”

In 1910 the estimated cultivated area under bananas and pineapples was 4742 acres. This does not include native plantations from which the bulk of the fruit is derived.

All fruit exported from the colony is subject to inspection by the Inspector of Fruit, and any fruit unfit for exportation is discarded by that officer, who also sees that all fruit is properly handled in shipment and carefully stowed

The values of "green fruit" (chiefly bananas) and quantities of bananas exported for the years 1906-11 were as follows :

	Value of Green Fruit in £	Bananas in Bunches	Cases
1906 . . .	97,678	604,617	191,640
1907 . . .	79,891	462,139	192,591
1908 . . .	62,217	356,180	145,110
1909 . . .	98,491	585,713	188,577
1910 . . .	47,302	271,024	81,225
1911 . . .	151,668	897,345	219,551

The increase for 1909 was due to some extent to the opening of a new market in Melbourne (Australia) to the banana planters of the colony by means of a subsidized steam service to carry the fruit in insulated cooled-air compartments. Unfortunately a hurricane occurred, accounting for the decrease in 1910.

The increase in 1911 shows that the hurricane had no ill effects, and that there was no serious blow during that year. Green fruit to the value of £33,145 was shipped to the Melbourne market by means of the greater facilities in transport during the year. The revenue derived from the imposition of the Banana Subsidy and Inspection Tax, levied under Ordinance XII of 1911, amounted to £1397 12s. 11d., against which the cost of inspection and subsidies on account of the banana trade amounted to £6133 10s. 10d.

Previous to 1911 the cultivation of bananas for export was confined principally to the Rewa Valley and to the Sigatoka District, from which the produce can be easily transported to meet ocean steamers sailing from Suva and from Momi, a port of call adjacent to the Sigatoka River. During 1911 a steamer of the Union Steamship Company made periodical visits to Savu Savu Bay district on the southern side of the island of Vanua Levu. This extension of the company's itinerary contributed to the increased export of bananas.

SOCIETY ISLANDS.—Nearly twenty kinds of plantains grow wild in the mountains. The native name is "fei,"

and they are probably forms of *M. fehi*. Bennett writes : "The Fei, or mountain plantain, beaten into a pulp, and diluted with coco-nut milk or water till brought to the consistency of arrowroot as ordinarily prepared in England, was formerly much used in the Society Islands. Large quantities were usually prepared for every festival ; a kind of cistern was made, with a framework of wood and a lining of leaves, which, when filled, was a sufficient load for six men to carry. Seven or eight of these were sometimes filled and carried on men's shoulders to one feast."

Moseley in "Notes of a Naturalist" writes of his experience of this plant at an altitude of 1600 ft. in the mountains of Tahiti : "The plant is closely similar in appearance to an ordinary banana, but the large bunches of fruit, instead of hanging down, stand up erect from the summit of the stem. They are bright yellow when ripe. . . . A fire is lighted and a bunch of these wild bananas is thrown into it. The outer skin of the fruit becomes blackened and charred, but when it is peeled off, a yellow floury interior is reached, which is most excellent eating and like a mealy potato. This is one of the very few plants which, growing spontaneously and in abundance, afford a really good and sufficient source of food to man. Hardly any improvement could be wished for in the fruit by cultivation. It could not but be most advantageous that the plant should be introduced into many other tropical countries."

NEW CALEDONIA.—A curious kind of *Musa* grows wild in New Caledonia. It produces no fruit, but it has a long, thick underground stem or bulb, which is boiled or roasted like a yam. The native name is "Poiete." The botanical name first given to it was *M. oleracea*, but it has been considered later to be a variety of *M. paradisiaca*.

PAPUA.—Bananas are cultivated by the natives together with vegetables and coco-nuts. The Jamaican banana has been sent from Jamaica through Kew to Papua, and is now well established there. F. M. Bailey states that the

bulb of a wild banana is boiled when young, or roasted when older, by the natives.

HAWAII.—The Jamaican banana * was first introduced into Hawaii early in 1903 by Mr. Philip Peck of Hilo, and again by the Board of Agriculture and Forestry at the close of the same year.

It has been known as the "Bluefields" banana from having been introduced first from that port in Central America.

The Borabora banana (*Musa fehi*) was probably brought to Hawaii from Borabora, an island of the same group, and originally from Tahiti. Fruit of fair quality when cooked.

The "Hua Moa" (Hen's Egg). The plant is of medium height, the leaf-stalks long and slender. There are only two or three fruits per bunch. The fruit is nearly as broad as it is long, and is of very superior flavour.

"Maia Hua Alua." Sometimes called "Mahoe." "The peculiarity of this variety is that it produces two bunches of fruit from the same stem."

"Maia Hapai." This is one of the most curious forms in the islands; probably Subang or Eel plantain of Java. It ripens its fruit within the stem.

A variety known to the natives as the "Brazilian" banana has been used for many years as shade for cacao; its fruit is superior in aroma to the "Bluefields," but it easily drops from the bunch on ripening; as it requires much more care in transport, it is not exported to any extent.

There is a large export of bananas to the United States.

SOLOMON ISLANDS.—The natives of these islands weave the fibre of a species of *Musa* by means of a native loom of a very primitive construction, and turn out cloth of a close texture and of a very durable character.

JAPAN.—A species of *Musa* (*M. basjoo*), the "Japanese Plantain," is cultivated in Southern Japan for its fibre. It is said to be a native of the Liu Kiu Archipelago (25° to 30° N. lat.). The fibre is exceedingly durable, and is used for making screens, and for binding books—it is not exported in the raw state.

* *Bulletin 7, Agri. Exp. St., Hawaii.*

CHAPTER XXVIII

GENERAL REVIEW OF CULTIVATION—*continued*

AFRICA

TROPICAL AFRICA.—According to Sir H. Johnston, the plantain is universally cultivated, but bananas are not common, and are of recent introduction, Arab or Portuguese. He maintains that the plantain was first introduced and cultivated on African soil by the ancient Egyptians, and reached the negro by slow descent from Egypt.

Speke says that the plantain is the food of the countries one degree on either side of the Equator, acres of ground being covered with its groves.

Burton, in "Central Africa," states that in the hilly countries around Uganda there are about a dozen varieties. The best fruit is that grown by the Arabs at Unyanyembe; it is still a poor specimen, coarse and insipid, stringy and full of seeds, and strangers rarely indulge in it. On Lake Tanganyika there is a very large variety called "elephants' hands"; the skin is of a brick-red, the pulp is yellow, with black seeds, and flavour harsh, strong, and drug-like.

Schweinfurth ("Heart of Africa"), speaking of the tribe of Monbutto, west of Uganda, says: "The growth of their plantain gives them very little trouble; the young shoots are stuck in the ground after it has been slackened by the rain; the old plants are suffered to die down just as they are; and this is all the cultivation that is vouchsafed. In the propagation of these plantains, however, the Monbutto have a certain knack of discrimination for which they might be envied by any European gardener; they

can judge whether a young shoot is capable of bearing fruit or not, and this gives them an immense advantage in selecting only such shoots as are worth the trouble of planting."

Stanley, in "Darkest Africa," refers to specimens of plantains that were "22 in. long, $2\frac{1}{2}$ in. in diameter, and nearly 8 in. round, large enough to furnish even Saat Tato, the hunter, with his long-desired full meal."

Stanley also says that he found a clearing beyond Yambuya in the great forest, "three miles in diameter, abounding in native produce. Almost every plantain stalk bore an enormous bunch of fruit, with from 50 to 140 plantains attached." He mentions several other places where the plantain groves were extensive.

SOUDAN.—The Abyssinian banana (*Musa Ensete*) is a native of damp valleys in Abyssinia, extending through the Soudan up the Nile Valley almost to the Equator. The fruit contains scarcely any pulp, but is full of large black seeds. The flower-stalk, before it has "shot" or emerged from the top of the trunk, is the portion of the plant that is eaten when cooked, and it is said that, prepared in this way, it resembles the cabbage of a palm. The same part of the plant in wild bananas is used in India.

The Nandi tribe of the East Africa Protectorate crush the seeds of a native species of *Musa*, and use the flour as food. The flour has been examined at the Imperial Institute,* and reported to have much the same composition as wheat flour, though it contained rather less proteins and rather more carbohydrates (chiefly starch). It is pointed out, however, that the preparation of a satisfactory flour on a commercial scale from these seeds would present considerable difficulty.

CANARY ISLANDS.—Dr. G. V. Perez of Puerto Orotava, Tenerife, to whom the author is indebted for specimens and information about sports of the Canary banana, has contributed the following notes to the *Gardeners' Chronicle* :

"Of the many species which have long been known in

* *Bull. Imp. Inst.*, x. 569 (1912).



FIG. 16. *MUSA ENSETE* GMEL.

Botanical Magazine, t. 5223. (By kind permission of the Director,
the Royal Botanic Gardens, Kew.)

the Canaries, the banana that has survived for the special purpose of the trade with Europe is the Chinese banana (*Musa Cavendishii*), the least tropical and therefore the most suitable for cool climates. Its cultivation is now at the height of its prosperity, and good irrigated land near the coast commands the almost fabulous rent of £40 per English acre. . . . The part of the Canary Islands where most of the bananas are cultivated is the well-known Valley of Orotava, owing to the comparatively abundant and never-failing supply of water, which, no doubt, filters down from the high and extensive plateau of the Canadas, nearly 7000 ft. high, and surrounding the famous peak of Teneriffe, which is over 12,000 ft. During the winter months there are abundant rains and snow, and the water gradually percolates to the region of the coast, where it is tapped by long, horizontal tunnels; in one case the tunnel is over a mile in length, and, although it does not rain for six months (May to October), the several water galleries show very little difference in their supply summer or winter. In one of these tunnels the output is three million gallons daily, and this water is carried along an aqueduct for a great distance to irrigate the land lying below it. In another instance a large supply of water (about one million gallons daily) that formerly ran to waste into the sea, falling from the cliff where it first made its appearance, has been pumped up nearly 1000 ft. high by steam, at a cost of over £40,000. It is then conducted by an aqueduct across the Valley of Orotava from west to east, a distance of six miles.

“It is owing to these circumstances and to the favourable geographical position of the Canaries for navigation and cheap freights that such developments have occurred in the banana trade. A further increase of plantations will certainly take place, at any rate in the neighbourhood of the Valley of Orotava, when more water is procured, and this will undoubtedly be the case, as several new tunnels are being bored in search of water with very good prospects of success. There still remain large supplies

going to waste at the coast, where they first appear, as in the previously named instance, and these await the necessary enterprise to have the water pumped up and made available to irrigate land which still remains unplanted with bananas, for which crop an abundance of water is an absolute necessity. The irrigation of land in this country makes an enormous increase in its value, for even if it is planted with ordinary crops, such as potatoes or tomatoes, the proprietor can get three such crops instead of a single crop each year, to say nothing of the enormous profits made from the cultivation of bananas which are unequalled by any known crop."

Mr. A. Samler Brown gives the following information* about bananas in the Canary Islands. After remarking that they will grow on irrigable land up to an altitude of 800 ft., he continues :

"Land planted with bananas takes about eighteen months to come into bearing. The roots should be planted about 12 ft. apart in rows about 12 ft. apart. This gives about 400 *cepas* or about 1200 to 1500 trunks to the Canary *fanegada* (approximately a square of 79 English yards). These should produce about 800 bunches a year. New land planted with old trunks will give fruit at from four to six months earlier than similar land planted with suckers. Not more than three suckers should be allowed to a trunk, the suckers being chosen so that they may come forward in their due order of succession. Expenses consist of labour, plenty of water, and some manure (generally chemical). About the year 1905 bananas in the Canaries began to suffer from the attacks of mealy bug, thrips, &c., and the necessity of combating these pests has considerably increased the expense of cultivation. When fairly started, a banana plantation gives little trouble, but the plant is rather difficult to kill, should it be necessary to clear the ground for other crops. The leaves used as litter rot slowly, but form a good manure, or they are used for packing. The stems serve as fodder for cows."

* "Madeira, Canary Islands, and Azores." Tenth edition, 1910.

The skin of this banana is much more delicate than that of the Jamaican, and it is necessary to pack the bunches carefully in strongly made wooden crates to prevent bruising and consequent destruction by rotting. The method employed is simple, but it requires some little experience to do it properly. The bottom of the crate is first covered with a layer of banana trash. The bunch is wrapped in a sheet of cotton-wool, which serves to protect the fruit ; it is then enclosed in thin paper. Thin strips from banana trunks are wrapped round the whole to keep paper and wool in position while it is being put into the crate. When carefully placed in the crate, trash is stuffed round to prevent the paper from unwrapping. The strings are then cut and pulled out, and more trash is inserted, to act as a cushion to prevent injury from the jars received in transit. The top of the bunch is also covered with trash, and then slats are nailed on to complete the crate.

“Each crate should have the shipping mark and a mark indicating the quality of the fruit stencilled on that end of the crate containing the flower end or small end of the bunch. The following method of marking is practised : A bunch weighing when in the crate from 40 to 49 lbs. (gross) should have one ‘X’ marked on the end of the crate, a bunch weighing 50 to 59 lbs. ‘XX,’ one weighing 60 to 69 lbs. ‘XXX,’ and so on. Bunches which weigh more than 60 lbs. should always be shipped by themselves, but when they weigh less, they may be packed two in the same crate, side by side. This fact is indicated by putting the figure 2 after the ‘X’s’ marked on the end of the crate.” *

The total quantity of bananas shipped in 1911 from the Canaries was 2,648,378 crates. The scarcity and consequent dearness of other fruits in 1909 had the effect of stimulating the consumption of bananas in Italy, France, and Germany, with the result that the fruit has become almost as popular in these countries as in the British Isles,

* *Journ. B. Agric., B. Guiana.*

and a regular trade has been established which is likely to grow in importance. In consequence of the rapid increase in the demand on the Continent, and in anticipation of a continued development of the trade with Continental ports, fruit was contracted for at relatively high prices. The exports of bananas from 1907 to 1911 were as follows :

	Crates		Crates
1907 . .	2,391,297	1910 . .	2,700,352
1908 . .	2,355,778	1911 . .	2,648,378
1909 . .	2,782,299		

The shipments during 1911 were :

To United Kingdom :		Crates	Crates
From Teneriffe . . .		781,831	
„ Las Palmas . . .		680,035	
		<hr/>	1,461,866
To Germany, from both islands .		732,503	
„ France „ .		365,714	
„ Italy „ .		48,424	
„ Spain „ .		22,677	
„ Other countries „ .		17,194	
		<hr/>	1,186,512
Total			<hr/> 2,648,378

The export to Germany and France continues to increase.

MADEIRA.—The Chinese banana is largely cultivated, and is exported to Lisbon and Oporto. The limit of production has apparently been already reached.

AZORES.—The area under cultivation of the Chinese banana increases every year.

EGYPT.—In Egypt it is calculated that there are upwards of 200,000 banana stools in the gardens round Cairo and Alexandria.

“ Bananas and plantains * have been cultivated for many centuries, especially in the north of the Delta about Alexandria, Damietta, and Rosetta, near the coast rather than inland. The tall-growing varieties cannot be grown

* “Text-book of Egyptian Agriculture.” By Foaden and Fletcher, (“Fruits,” by G. Bonaparte). ii. 617 (1910).

with success near the sea without the protection of a high hedge or wall on account of the continuous strong north wind. During the last few years the dwarf banana, *Musa Cavendishii*, has been introduced and cultivated with considerable success, particularly near Alexandria, at Gabbari, Ramleh, &c., and along the Mahmudia Canal. It is well adapted to the north of the Delta, and is much less subject to damage by the wind. Unfortunately, it has recently fallen a victim to a nematode worm infesting the roots, which has destroyed large areas of this banana.

“ Among the bananas grown in Egypt the following are the most important :

“(1) The *Baladi* (*Musa sapientum*), or banana proper, is a tall variety, chiefly grown inland, and is the most common variety in the native gardens of Cairo. The fruit is somewhat short and thick, 4 to 6 in. long, and greenish yellow outside. The pulp is rich in saccharine substances and highly fragrant. It has a delicate flavour and is in great demand. It supplies its fruit from about the beginning of autumn till spring.

“(2) The *Sobaa-el-Sit* (*M. sapientum*), or banana proper, is a small-fruited variety, the fruit being thin and somewhat curved, about 3 in. long, and of a rich golden-yellow colour outside. It is at its best in autumn, but is inferior to the preceding.

“(3) The *Hindi* (*M. Cavendishii*) or Chinese banana, is an excellent banana and deserves greater attention. It is a yellow banana, 5 to 6 in. long, thick-skinned and slightly curved. The pulp is rich both in flavour and fragranc^y. It has the greatest share in the traffic, and is in great market demand. The fruit is found all the year round, but is at its best late in summer and in spring. For general purposes it is the best sort grown.

“(4) The *Americani* (*M. paradisiaca*) Plantain, or Adam's Fig, is a lofty plant, a heavy cropper, with very large fruits which often attain a length of 14 in., though they are usually about half that size. The fruit is angled and of a yellow colour ; the pulp is firm but almost destitute

of sugar, poor in flavour and aroma, and with rudimentary seeds in it. It is only good when cooked ; it is cheap and in small demand. The plant, however, is very decorative and is often planted as such in gardens.

“Banana cultivation is one of the most productive exploitations in Egypt, though at present it is almost entirely confined to gardens. Sufficient bananas are not cultivated to supply the Egyptian market, and large amounts are imported from Madeira and the Canary Islands. The best size of suckers for propagation are from 3 to 5 ft. long, according to the variety ; they should be thick and vigorous, taken from healthy stocks, producing superior fruit and coming early in season. The holes for planting out are dug along an irrigation trench to a depth of about $1\frac{1}{2}$ ft., the bottoms well pulverized and dressed with well-rotted farmyard manure. The most favourable time for planting is from about the middle of February till the end of March. Whilst the plant is young, all the suckers except one should be cut away ; thus all the vigour of the plant is thrown into the fruiting of the first stem, and in this way fine large bunches can be reckoned on. Afterwards when the stool has matured, three or four stems only may be allowed to grow, according to the vigour of the stool. An application of water is given immediately after planting, and then at short intervals till the plants are well rooted. Water is then wanted less often, and when the plants are fruiting, especially towards the end of the ripening process, it will be advisable to give water at longer intervals, as too much water at this time is disadvantageous. The fruit is cut about eight or ten days before it is ripe, when it begins to turn somewhat yellow. If left to ripen on the tree, it loses much of its flavour, often rotting. If cut when nearly ripe, the fruit is carefully hung in a dry place, but if cut earlier it is placed between layers of straw, and sometimes weighted, where it will become ripe, mellow, and acquire its saccharine flavour and fragrantcy.”

A writer in the *Gardeners' Chronicle* (July 1907) gives the following particulars : “ Growers of bananas rarely

realize less than £60 clear per year per feddan (a little over an acre), and from one plantation of 25 feddans the owner has this year made a profit of over £2000. . . . Egypt is more favourably situated than any other country for a banana trade with the Mediterranean, Adriatic, and Black Sea ports. As compared with the Canary Islands, the cost of transport from Egypt is in most cases less than half. The export trade of Alexandria and Port Said is served by numerous lines of fast up-to-date boats, which daily leave these ports for all parts of the world."

WEST COAST.—It is possible that both the French and British colonies on the West Coast of Africa can successfully compete with tropical America for the European trade, and experiments in the cultivation of various kinds are being carried on by all the agricultural departments as to their value.

FRENCH GUINEA.—In point of accessibility,* and in the possession of suitable soil and climate, as well as cheap and abundant labour, the littoral of French Guinea immediately north of Sierra Leone is considered by the French colonial authorities to be one of the most promising regions in West Africa for the development of a fruit trade, and it is believed that French Guinea will be able to compete with British importations from the West Indies, and even to replace them on the London market.

French Guinea possesses a hundred miles of railway, carrying fruit at a special rate, and terminating at a convenient port capable of accommodating ships of 4000 tons. The cost of land is insignificant, and there is an abundance of good and cheap agricultural labour. The coast regions are well watered with innumerable creeks. There is a wet and dry season, each of six months' duration, the wet season lasting from May to October. Farther inland fertile valleys, the soil being laterite, penetrate the high plateaux which separate the head waters of the Gambia from those of the Niger.

* "Bananés et Ananas." By Yves Henry. Paris. See *Bull. Imp. Inst.*, iii. 62 (1905).

A number of plantations of the Canary Islands banana have been established in the neighbourhood of Konakry. Communications with France have been established; consignments first despatched in 1902 have been continued every month. The experience, however, of planters is that in Guinea the culture of the banana ought to be intensive, and that it would be imprudent to attempt it on a large scale; M. Henry recommends that a plantation should not exceed 20 hectares (say about 50 acres).

Whereas in the Canary Islands the young plants generally begin to bear fruit a year or eighteen months after being planted out, in French Guinea they bear at the end of eight or ten months. But the suckers left with the mother-plant will often bear fruit when only four months old, if the land is irrigated and well supplied with chemical manures. The bunches must be supported with posts, otherwise the weight of the fruit is apt to bring down the plant. About sixty to eighty days intervene between the time of flowering and the ripening of the fruits. When ripe, the bunches are cut in the evening, put in an airy place for the night to sweat, and packed on the following morning. Plenty of bananas reach Europe during June, July, and August. Ripening may be retarded for a month or so by cutting off the extremity of the bunch with the sterile bracts, so that the bananas may come to Europe a month later, when there is more demand. A banana plant seldom yields good bunches in its first year, but in its second year will yield bunches worth exporting.

In French Guinea, as well as in the Canary Islands, the soil is generally poor and requires manure, and in both an intensive system of culture pays best.

Three principles must be observed: (1) fruit formation should be discouraged during the wet season, when cropping and transit are difficult; (2) application of manure during the wet season is almost entirely wasted; (3) chemical manures must be applied gradually to ensure their producing the maximum effect.

In packing, the bananas are carefully brushed, en-

veloped in cotton-wool, then in dry paper, and placed in open octagonal wooden crates which freely admit air. The bottom of the crate is lined with hay, straw, maize leaves or banana leaves cut up and dried. Empty spaces are firmly stuffed to prevent oscillation in transit.

An efficient and cheap way of manufacturing meal is simply to peel the bananas and dry them in the sun. But as there are six months of rain, from May to October, it is necessary during those months to have recourse to artificial driers. It is found that from a given weight of fruit 20 per cent. of flour is obtained. It has been ascertained in the course of experiments in Guinea that although unripe and partially ripe bananas may be converted more quickly into meal, ripe bananas which contain more sugar give the best results.

CONGO.—“Cette richesse végétale du bassin entier s'augmente d'une plante qui, avec l'élaïs de Guinée (palmier à huile), suffit à caractériser la végétation congolienne ; il s'agit du *bananier* qui croît sur presque toute l'étendue du bassin. La beauté de son port embellit les sites des villages qu'il entoure ; son fruit exquis constitue une des plus riches ressources alimentaires du pays ; sa fibre souple and son feuillage géant servent de matière première à l'industrie indigène.”*

SAN THOMÉ.—In the island of San Thomé about a dozen varieties of banana or plantain are cultivated, some from Brazil and Madeira, but chiefly from the neighbouring coast of Gabun. One of the varieties has the leaves and the long fruits copiously striped with white, and the bracts are bright red inside ; the botanical name is *Musa sapientum* var. *vittata* ; (see Fig. 17, p. 215).

CAMEROON.—In the German colony of Cameroon much attention is devoted to the subject of the cultivation of the banana and the export to Europe. It is pointed out that the distance to Europe is not greater than from Costa Rica to Liverpool, and that there are many places on the coast very favourable to loading ships. Steps are being

* “Le Congo Belge,” by J. Bertrand, p. 67 (1909).

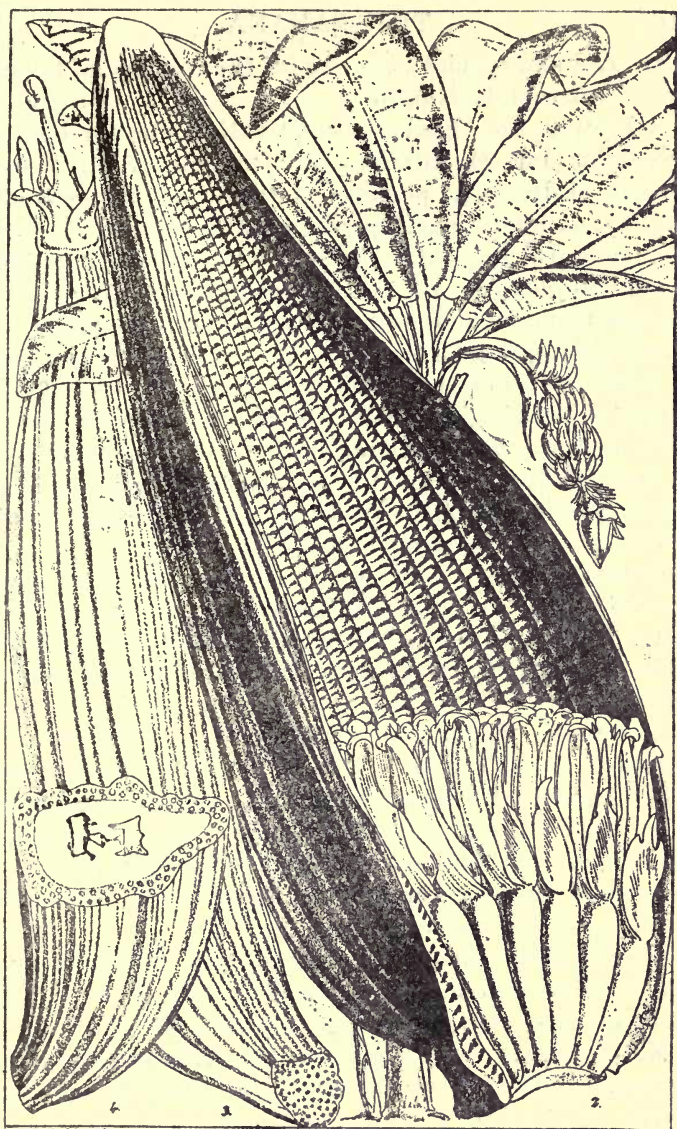


FIG. 17. *MUSA SAPIENTUM* VAR. *VITTATA* HOOK. F.

(*Botanical Magazine*, t. 5402.) 1. Plant in fruit reduced. 2. Bract and hermaphrodite flowers. 3. Unripe fruit. 4. Transverse section of same. (By kind permission of the Director, the Royal Botanic Gardens, Kew.)

taken to build special steamers for the carriage of bananas from Cameroon to Hamburg.

ALGERIA.—In Algeria the cultivation was for long unsuccessful, but M. Rivière, the Director of the Botanic Garden at Hamma, persevered through numerous difficulties, and has at length produced a variety, the “Hamma banana,” which yields excellent fruit, ripening perfectly along the littoral zone. The original of the Hamma banana came from Brazil; many of the first plants died down to the ground from cold; some were sufficiently hardy to resist cold, but their fruit was abortive. However, by careful selection of bulbs M. Rivière’s efforts were crowned with success. The cultivation of the Chinese banana was at first a failure, until it was found that it required shade, and now it is possible to grow this species yielding bunches with 150 to 180 bananas.

GERMAN EAST AFRICA.—According to the reports recently sent to the Committee of German Colonial Agriculture, a number of excellent varieties are cultivated, some specially for flour, some for cooking, and some for fruit.

ZANZIBAR.—Numerous varieties are cultivated, but the chief use of the banana is for shade in plantations of other plants. To ripen the fruit, the natives dig a large hole, make a fire in it to kill all organisms, and then bury the bunch. At the end of five days the fruit is ripe, the process of ripening the bunches hung up in the open air requiring ten or twelve days.

SEYCHELLES.—Special apparatus for drying bananas has been erected in which the fruits are dried in about 18 hours at a temperature not exceeding 65° to 70° C.

MADAGASCAR.—Bojer gives a list with descriptions of bananas cultivated in Madagascar. There is no export trade.

MAURITIUS.—Bojer enumerates seventeen species and varieties of banana and plantain cultivated in Mauritius. Horne mentions a wild banana, called the “*bananier à graines*,” which produces edible fruit with seeds. He says :

"Every clump of this (wild in the mountains) is known to the coolies and Creoles, who readily eat the fruit, which must therefore be watched to obtain it in a perfectly ripe condition. The stems of this banana abound in fibre of excellent quality. . . . I have raised plants from seeds."

NATAL.—Bananas form the staple food product, and for these there is an increasing export trade throughout the South African Union. Mr. Claude Fuller states that this crop—worth £80,000 per annum—is largely in the hands of Asiatics, only a few European planters being engaged in this culture.

CHAPTER XXIX

GENERAL REVIEW OF CULTIVATION—*continued*

SOUTH AMERICA

BRAZIL.—Many varieties of bananas or plantains are cultivated in Brazil, and there is an export trade to Buenos Ayres. The bananas which are most commonly cultivated are the "Catura" (the Chinese banana) and the "Massao" or "Maça," a variety of *Musa sapientum*. It would be worth while to get suckers of this banana from Brazil and investigate its merits by growing it at experiment stations.

The following account of the cultivation of the Catura and Massao bananas in the State of Parana is written by M. Paszkiewicz for the *Journal d'Agriculture tropicale* and translated by Dr. J. Neish : *

"The Parana is a district of Southern Brazil. Sugarcane and bananas are the objects of cultivation. It is the small or Chinese banana which is generally cultivated. The natives call it the Catura. This sort is known to be the least exhaustive of soils, but yet a bananery in the Parana with reputedly rich and good soil shows signs of exhaustion in the course of eight years. A clearing is made, and the felled timber is chopped up and left on the ground. Two months of dry weather suffice to dry it, and it is then burnt. Many stumps remain in the ground and the heavy logs also remain, but as the cultivation is all by hand labour, these impediments do not much interfere. The soil has no need of further preparation. Small holes are made with the mattock about twelve feet distant, in

* *Journ. Jam. Agric. Soc.*, ix. (1905).

which are placed the suckers taken from old bananas ; they are lightly covered with earth. Very soon the sucker begins to vegetate and rapidly covers the ground with its broad leaves. It grows so rapidly that in the course of a year each plant will produce a fine bunch of bananas. During this time the plant has only required two or three hoeings with moulding proportionate to the height of the plant. Every stem having flowered and ripened a bunch is destined to perish ; it is therefore cut down at the time of removing the bunch. But this first stem is replaced by numerous suckers which have grown whilst the bunch was growing and ripening ; these suckers are taken up except two or three, each of which will give a bunch a few months after the primary bunch was cut ; and this will follow in the same course every year until the exhaustion of the mother-plant, which is shown by a sensible diminution in the vigour of the plant, and by the production of small bunches which are often very defective. This exhaustion can be kept back by good cultivation, and by taking care not to allow any more suckers to grow than the fertility of the soil permits the banana to nourish—that is to say, three in general, four at the most. There are bananeries which, notwithstanding whatever may be done, are exhausted at the end of seven or eight years ; whilst there are others which remain in full vigour for twelve years. When it becomes necessary to proceed to the pulling up of the bananas, the soil will be found to contain, so to speak, no more bananas or roots of trees ; they are for the most part decomposed. Cassava may then be planted, or sugar-cane. The soil is in fact far from being exhausted ; it contains a proportion of humus quite as great as, if not greater than, when it was cleared, on account of the decomposition of the stems and leaves which were cut up in small pieces and then spread upon the surface of the ground. The banana plant produces an enormous quantity of alimentary substance. According to observations made in the Lower Parana, a hectare ($2\frac{1}{2}$ acres) yields a harvest of 50,000 kilogrammes (110,000 lbs.) ; and it is neither

rare nor difficult to obtain in good land from 80,000 to 120,000 kilogrammes.

“The Catura is the banana the cultivation of which on a large scale is the least difficult, but it is far from being the sole variety cultivated in the Lower Parana. We find there, in fact, numerous forms or varieties of the *Musa sapientum* and *Musa paradisiaca*, amongst which may be cited the Massao, Oura, Saint Thomas, belonging to the series of fig or true banana; the plantains Maranhao, Da Terra, Falta Velhaga, Da India, &c. Of all these bananas, and without speaking of the Catura, it is the Massao which is the most commonly cultivated: it is, in fact, the banana which presents the most advantages, and best lends itself to an extensive culture.

“The Maça banana, or Massao, is a magnificent plant, with a height of thirteen to nineteen feet, and with leaves from nine to thirteen feet in length. It goes without saying that for this plant to attain all its development and for it to produce fine bunches, it is necessary that the Massao should be cultivated in soils of a high degree of fertility. Much more exacting in fact than the Chinese banana, the Massao does not prosper really well except in very rich soils, very deep, and always cool and moist—alluvial valleys; it does not fear even, but quite the contrary, the soils of those valleys which are liable to be flooded from time to time after great rains. On high grounds and in dry and shallow soils this banana vegetates slowly and only produces bunches of no value, rapidly perishing but it produces fine and excellent fruits, and its duration, so to speak, is indefinite when it is planted in a soil which is favourable to it. The vegetation of the Massao is so vigorous that it quickly grows above the surrounding plants; thus the hoeings are not long in becoming useless. But it is always indispensable to carefully destroy the greater part of the suckers produced by the parent stock, and sometimes more than sixty may be counted. These suckers are to be removed in proportion as they appear, and in sparing always a certain number, six or eight in

the case of vigorous plants, in order to replace successively the stems which have borne fruits.

“ It is calculated that on an average each stool of Massao in a plantation can give annually at least five or six fine bunches ; and notwithstanding that these plants have been set out at a distance apart at least double those of the Catura, their product is nevertheless more considerable than that of the Catura. On comparing the yield of a plantation of one thousand stools of Massao banana with that of the same number of the Catura, one can easily account for the superiority of the first over the second from the point of view of production. One thousand stools of the Catura produce annually from 2000 to 3000 bunches, say on an average 2500 bunches of an average weight of 35 lbs. Bunches of the Catura weighing 44 to 55 lbs. are in fact exceptional, and many bunches only weigh 26 lbs. In ten years, which is the ordinary duration of a plantation of Caturas, there will have been harvested 25,000 bunches of a total weight of 9,600,000 lbs. During a similar period of ten years, 1000 stools of the Massao will have produced 55,000 bunches—that is, 5500 bunches per annum ; which, taking the average weight of 23 lbs. per bunch, makes a total of 18,150,000 lbs. in ten years. It will be seen therefore what an enormous difference exists between the production of the Caturas and that of the Massaos. The commercial usages of Southern Brazil make this difference still more sensible, and for this reason : the bunches are not sold by weight, but always by the dozen ; it is therefore much more advantageous for the producer to harvest a very large number of bunches, having dimensions and a weight sufficiently marketable, than to obtain only a small number of bunches, even though they may be much heavier. It will not do, however, to push this reasoning to the extreme, for fine bunches are more easily sold and have the preference over others. Finally, when the period of ten years indicated above shall have terminated, it is quite probable that the Caturas will be almost entirely exhausted, and the plantation will require

renewal ; whilst, on the contrary, the Massaos, always in full vigour, will still continue during several years to give the same product. It appears therefore, at first view, that between the two species there can be no hesitation which to plant, and that it is necessary to plant the Massao in preference to the Catura. Unfortunately every medal has its reverse, and if on one part the culture on a large scale is incontestably more profitable than that of the Catura, there is room to state, on the other hand, that fine and productive plantations of Massaos are very far from being made everywhere, and that, on the contrary, this banana requires in order to succeed conditions of soil and of situation which it is not easy to find combined together.

“I have already stated the requirements of the Massao relative to the nature and the quality of the soil ; but besides, as there is the grave defect of badly resisting the action of the wind, it can only be cultivated in sufficiently sheltered places, without which the risk is run of high winds causing great damage in the plantations. The Catura, on the contrary, thanks to its short stature, resists all winds ; and if its duration is not so long as that of the Massao, as a compensation it contents itself in soils in which the Massao would give no crop.

“The fruit of the Massao is of medium size. A bunch weighing from 26 to 33 lbs. is made up of six to seven hands, and bears about one hundred fruits. The fruit is excellent, its flesh tender, buttered, sugared, and deliciously perfumed ; the bananas which we see in Europe, produced by the Chinese banana, cannot be compared with a good Massao banana, taken when perfectly ripe. Unfortunately, the Massao banana, more delicate, bears carriage less easily than the Catura banana. Nevertheless, the Argentine steamers load great quantities in the bay of Paranagua, to carry them to Buenos Ayres, where they are much appreciated.”

“Bananas and plantains * grow from Amazonas to Rio

* “Brazil in 1911.” By J. C. Oakenfull. 1912.

Grande do Sul, but are hardly found above 3000 ft. in the southern and central States. There are many kinds cultivated, and we may enumerate Pacova (in Pará), a very large plantain, usually eaten fried or boiled; the outside is red. *Musa Cavendishii* (Anã) has a short trunk, dark leaves, and produces huge bunches of fruit of a long, curved, and cylindrical form, light yellow coloured. *Musa sapientum*—trees high and rounded fruit. Exportation of bananas in 1907, 1,878,904 bunches. Each bunch weighs on an average 45 lbs., and the heaviest attain 125 lbs., or up to 300 bananas. Freights from the plantations in São Paulo (near Santos) to Buenos Ayres (Argentina) total about 12s. 6d. per dozen bunches. In Santos there are some 200 planters who only cultivate one class (the Anã), most of them occupying the lands without any right of ownership, as they are the property of the State, and have never been considered worth selling. Each kilo of bananas exported pays 1 real of duty, equalling 1½d. per 100 kilos.

“In Cubatão (near Santos) one planter has 500 alqueires under bananas, and the whole of the district is devoted to this culture. The whole of the banana traffic is limited to the coast-line from Rio de Janeiro southwards. Pará and Pernambuco are so well situated, however, with regard to exportation to Europe, that doubtless when their port works are completed they will prove the shipping centres of an immense trade. The best variety in Brazil is known as the Banana de São Thomé, as it is of African origin.

“Some plantations more than thirty years old are still producing, the only attention given being the clearance of extraneous matter from the vicinity of the plants; and the bunches average seventy bananas even after such an extension of time. There are reckoned to be 2,000,000 trees within the district above mentioned. Labourers employed in cutting the bunches are paid at the rate of 4s. 6d. to 5s. daily.”

In the State of Parana banana plants are plentiful on

the coast, and the fruit is exported to Argentina. But there is scarcely any fruit cultivated in the interior, although both soil and climate are well adapted for fruit-growing.

There is an export of bananas from Santa Catharina. In 1910, 744,152 bunches were exported, the value of which to foreign countries was £1190 and to Brazilian States £336.* Also in 1910 there was an export from the port of São Francisco do Sul, Santa Catharina, of 6000 bunches to foreign and of 18,000 bunches to Brazilian States.

In the State of São Paulo fruit cultivation is extending rapidly, and bananas are largely exported. From the port of Santos, São Paulo, the exports of bananas for 1908-10 were :

	Bunches	Value in Milreis †
1908	346,633	.. 272,015
1909	467,272	.. 362,889
1910	757,983	.. 637,752

PARAGUAY.—Planters in Paraguay have imported all the Brazilian varieties, and ten years ago there were about 120,000 acres under cultivation.

ARGENTINA AND CHILE.—Bananas are grown in these countries, but only in quantities sufficient for their own consumption.

PERU.—The Peruvians use plantains like bread or potatoes as the basis of their food-supply; whereas the Brazilians employ cassava in the same way. Plantains are generally harvested when "full" only; they are boiled, which renders them mealy like potatoes, though a little harder. They are also roasted, or made into flour and mixed with butter. Sometimes they are allowed to become quite ripe, and are then eaten as a fruit. Bananas are not cultivated much at present, but there are several well-known kinds, the best of which is the "Guinea," known to the Brazilians as "Banana de São Thomé."

* These values seem too low; they are quoted from *Diplomatic and Consular Reports*.

† Value of paper milreis, about 1s. 4½d.; of gold milreis, 2s. 3d.

VENEZUELA.—The banana and plantain are cultivated throughout Venezuela, but fruit is not exported. A North American company has bought land near Lake Maracaïbo for the purpose of growing bananas; and they might become a very important export.

The *Kew Bulletin* gives an account of the principal varieties as described by Diaz: "A plantain called 'platano' or 'platano arton' is widely distributed. 'Platano domenico,' the royal or small-fruited plantain, is similar to the common plantain, but the fruit is smaller, and the plant bears cold better. The 'platano topodes' is like the plantain in the character of the fruit, and like the red banana in its power of resistance to dry weather. The fruit, when ripe, is readily eaten by man and animals. The red banana, 'cambur morado,' differs from the preceding in the colour of the stem and fruit. The fruit of the red banana is specially suitable for preserving by being dried in the sun. The topodes and the red banana are preferred as shade plants on coffee lands on the hills. The creole banana, 'cambur criollo,' is a smaller plant than either of the two preceding; the stem is stained with blotches and black streaks; the fruit is small, but a very palatable dessert fruit—in a green state, it is put into the Spanish olla or stew. The apple banana, 'cambur manzano,' has the stem and leaves tinged with red; the fruit is as small as the creole banana, it has a very delicate flavour, and is the most highly esteemed of any. The Chinese banana, 'cambur pigmeo,' is also cultivated.

"In propagating, it is considered important that the suckers should not be removed until the parent stem has perfected its fruit, otherwise the latter will not fully mature. Suckers are put out at distances of 9 or 12 ft. according to the fertility of the ground. During the first year, catch-crops, such as maize, peas, and beans, are sown between the rows. Weeding is done twice a year."

GUIANA.—In British and French Guiana all the best bananas are grown, but they are for local use only, none being exported. It is estimated that the area in British

Guiana under cultivation with plantains and bananas amounts to 17,800 acres.

The plantain chiefly grown is the "white plantain" with green stem and leaf-stalks; it is prolific and very valuable, as the fruit is of the best quality. The "black plantain" is similar, but the leaf-stalks and stem are purple or blackish. The "giant" or "horse plantain" has very large fruit. There are regular plantations of plantains, whereas bananas are grown in mixed cultivation. Plantains are considered an essential article of food, while bananas are a luxury.

The most common banana grown is the well-known Chinese. Other varieties are: "Small fig" or "Lady's Finger"; fruit densely packed, clear straw colour when ripe, 3 to 4 in. long, pulp melting, flavour good. "Large fig" or "cokerite"; fruit curved as a rule, 4 to 5 in. long; good bunches contain 300 to 400 fruits—strongly recommended for export purposes. The Jamaican is not so common as any of the above. The "Surinam" or "sour banana"; fruit 6 to 8 in. long, straw-coloured, pulp rather woolly with harder centre, of somewhat acid taste. "Giant green" or "Canaan banana"; fruit stout, densely arranged, 6 to 7 in. long, colour yellow. "Giant red"; fruit stout, dull red, 5 to 7 in. long, flavour good. "Arrababa" or "apple banana"; fruit of soft texture, slightly acid, 7 to 8 in. long, skin very thick, pale yellow; "not of much use for eating raw like other bananas, but cooked it is the best of all." Chinese; produces heaviest bunches, often with 200 fruits.

Messrs. Harrison and Jenman experimented with bananas. They state: "The banana is a gross feeder and requires liberal cultivation. A copious rainfall, good soil and tillage, free drainage and liberal dressings of manure where the ground is permanently used, are all essential conditions to the production of first-class fruit. When stable dung is procurable, its application pays well. In the experiments we have tried with artificial manures, sulphate of ammonia, applied about 2 cwt. to the acre at

a time, appears to have produced the best results. Plantains require much the same system of cultivation as that described for bananas, but give a heavier yield from the same land. They delight in the stiff, newly empoldered clay lands of British Guiana, not objecting to the slightly saline element found where the sea or river has invaded the place periodically at spring tides, while it was lying fallow under the natural bush growth. Such lands yield heavily. . . . New lands produce the most luxuriant plantain growth, and are used for this purpose by estates, as they will not at first grow canes well, but after a few years of plantain and ground provision cultivation, they become adapted to the requirements of sugar-cane cultivation."

The experience of ten years on a cultivation of from 400 to 480 acres in plantains is given by the planter as follows : Four hundred suckers are planted per acre at 12 ft. apart in rows 9 ft. apart ; 75 per cent. only of the suckers succeed, and their places have to be supplied. On a well-kept cultivation every acre will give 300 good and 50 inferior bunches per annum. The keeping up of the plantain estate on a large scale costs about £6 per acre per annum, supposing the estate to be already in good working order.

Dr. Shier, of Demerara, paid considerable attention to the preparation and use of preserved plantains and bananas and of plantain flour. His studies were reported in the "Catalogue of the Paris Exhibition of 1867," as follows :

"*Preserved Plantains and Bananas.*—It was supposed that the dried yellow plantain or banana might come into competition with figs, and the sample exhibited at the great London Exhibition of 1851, which had been prepared in Mexico many years before, proved the great superiority of the *platano pasado* over figs in keeping properties and in immunity from insect ravages. In Mexico, the simple exposure of perfectly ripe plantains or bananas to the sun's rays is sufficient to prepare them for the market in an exportable form. . . . But whether from the greater moisture of this climate, or a greater proportion of nitrogenous elements in our plantains and bananas, it is

found in practice that simple solar exposure is not adequate for the preparation of this dried fruit. There are three modes, however, by which the object can be attained : 1st, by exposing the fully ripe fruit to an atmosphere of sulphurous acid gas, previous to the drying process being commenced ; 2nd, by a hasty boil of the fully ripe fruit in water containing sulphate of lime (hard water) ; and 3rd, by a simple parboil in syrup. By any of these processes the albumen and casein of the fruit become sufficiently coagulated, and the tendency to fermentation and decay is arrested till the proper dryness is obtained. There is some nicety required in knowing the best degree of ripeness of the fruit. It should be full and beginning to turn yellow before the plantain tree is cut down and the bunch gathered. The fruit then should be kept either on the stalk or separated in a close dry place, as recommended in the Mexican plan, till the yellow of the rind has become black at the ends, with large spots over the surface, till on some of these black spots blue mould has begun to appear, and swarms of small grey flies hover over the heap, attracted no doubt by the saccharine odour, and till the fruit yields to a slight pressure of the finger and is somewhat supple in the hand. At this time, if some of the rind be removed, portions of the opaque yellow surface will appear as if melting. There should be no delay then in parboiling, or the fruit will be lost. If, on the other hand, the drying process is commenced too soon, a portion of the starch is still unconverted, and the dried fruit will be hard and want sweetness. This condition is easily discovered after the drying is completed, by the absence of a due amount of shrinkage in the fruit. To dry the fruit in the sunshine a bamboo frame as used in Mexico, or a net, or any other contrivance by which the sun and air can play upon them, is suitable. They must, however, be removed to shelter on the approach of rain or evening dews. In rainy weather the heat of an oven is requisite, but the oven should be left open at the mouth, else the fruit will be baked instead of dried, and the heat should be comfortably bearable by

the hand, else the sugar will be carmelized, and the core of the fruit blackened and rendered bitterish. Tight close packing in drums under considerable pressure, as with figs, would no doubt contribute materially to the preservation of dried ripe plantains and bananas."

Plantain Meal.—"The plantain is sometimes so abundant and cheap that it might, if cut and dried in its green state, be exported with advantage. It is in this unripe state that it is so largely used by the peasantry of this colony as an article of food. It has always been believed to be highly nutritive; but I have not found in any sample of the dried plantain which I have analysed a larger amount than .81 per cent. of nitrogen, which corresponds with about $5\frac{1}{2}$ per cent. of protein compounds. When dried and reduced to the state of meal, it cannot, like wheat flour, be manufactured into maccaroni or vermicelli, or at least the maccaroni made from it falls to powder when put into hot water. Plantain meal is prepared by stripping off the husk of the plantain, slicing the core, and drying it in the sun. When thoroughly dry, it is powdered and sifted. It is known among the creoles of the colony under the name of *conquintay*. It has a fragrant odour, acquired in drying, somewhat resembling fresh hay or tea. It is largely employed as the food of infants and invalids. In respect to nutritiveness, it deserves a preference over all the pure starches on account of the protein compounds it contains. The plantain meal would probably be best and freshest were the sliced and dried plantain cores exported, leaving the grinding and sifting to be done in Europe. The flavour of the meal depends a good deal on the rapidity with which the slices are dried, hence the operation is only fitted for dry weather, unless indeed, when there was occasion for it, recourse were had to a kiln or stove. Above all, the plantain must not be allowed to approach too closely to yellowness or ripeness, otherwise it becomes impossible to dry it. The colour of the meal is injured when steel knives are used in the husking or slicing, but silver or nickel blades do not injure the colour. Full-sized and well-filled bunches

give 60 per cent. of core to 40 of husk and top-stem ; but in general it would be found that the core did not much exceed 50 per cent., and the fresh core will yield 40 per cent. of dry meal, so that from 20 to 25 per cent. of meal is obtained from the plantain, or 5 lbs. from an average bunch of 25 lbs., and an acre of plantain walk of average quality, producing during the year 450 such bunches, would yield a ton and 10 lbs. of meal. Even supposing the meal not to command over half the price of arrowroot, it would still form an excellent outlet for plantains whenever, from any cause, the price in the colony sank unusually low."

F. A. Stockdale, writing in 1909 on the question of the establishment of a banana industry in British Guiana,* states that a large amount of the coast lands would not be suitable for the successful cultivation of bananas—poor land or worn-out cane land will not produce first-class fruit. It is probable, if means of transport to the seaboard were readily available, that much of the back lands would suit admirably. A good deal of the land on the lower parts of the rivers should also grow good crops of bananas.

The Commission of 1910 reported that the greater part of the readily available front lands of British Guiana is not suited for the production of bananas on a commercial scale, and considered it hopeless to look for their production on such a scale on the wind-swept abandoned lands of the present sugar estates and of earlier cultivations.

SURINAM.—The history of the establishment and short life of the banana plantations and trade in Surinam is somewhat melancholy, but it illustrates not only the unconquerable spirit of a brave community in taking up a new cultivation when their cocoa had been so disastrously attacked by the "witch-broom" disease, but also the help which an enlightened Government can give in fostering a new industry. It is to be hoped that the last has not been heard of an export trade in bananas from this country, and that although the Congo banana has not

* *Journ. of Board of Agric.*, iii. 72 (1909).

proved successful in the fruit market, another variety may be found which will be both immune and have the good qualities of the Jamaican as well. If a good watch is kept on the Jamaican plants now in the colony, and suckers from the least susceptible stocks are taken continually, it might be possible to develop a native immune variety.

Dr. J. Kuyper, Government Botanist in the "Department van der Landbouw," in a communication to the author dated January 1913, has very kindly contributed the following account of the efforts made to establish a banana trade :

"The banana business was started in the year 1906. There was a contract between the Government and the United Fruit Company, and between the Government and the estates. The Government bought the fruit from the estates, which were not allowed to sell their fruits to any other person or company than the Government; the United Fruit Company took upon itself to send steamers and to buy up all the available fruit. The Government made advances and got as security mortgages on the estates.*

"The species planted was the Jamaican or Gros Michel banana. The estates took upon themselves the obligation to plant 6900 acres in bananas in three series of 2300 acres each. In 1907, 2300 acres were ready, and towards the end of the year the managers began with a new series of that acreage. In that year already some cases of Panama disease were noticed, but it was not yet serious. On December 31, 1908, 7600 acres were planted with bananas; so the acreage was a greater one than the estates were obliged to keep up. In 1908, 219,663 bunches were shipped, for which the United Fruit Company paid fl. 110,076.93 (Dutch currency). The Panama disease had already done great damage, but not yet so much that the

* The Government advance was at the rate of about £30 per hectare (= 2½ acres) for the first year of planting and £15 for each following year, the amount to be refunded from the proceeds of the crop.—Dr. van Hall in *Tropical Life*, April 1908.

fields were entirely destroyed. In 1909, 648,636 bunches were shipped. The Panama disease so terribly damaged the estates in that year that it was quite impossible to keep the fields under cultivation; new suckers were infected in a short time, so that it was impossible to replant the fields with the Gros Michel variety. In this year the Manager of the United Fruit Company introduced a new variety, the 'Congo' banana; the place from where it came was kept a secret, but probably it came from Porto Rico. In 1910 whole fields were abandoned; every hill was attacked; one estate only had a few cases; 152 acres gave 33,685 bunches, for which was paid fl. 15,324.00 (Dutch).

"Only a few Congo bulbs were given to the estates; the greater part was placed in nursery beds to get a large amount to be divided to the estates in 1911. On those nursery beds, formerly heavily infected with Panama disease, a few cases (about 10-20) of the Panama disease were noted in September 1910. Of course every one was very anxious that the disease should not spread over the new fields, but happily in the year 1911 not more than a hundred cases were stated on all the fields planted with Congo bananas, the acreage of which amounted to about 2100 acres on December 31, 1911. In the year 1911, 384,097 bunches were shipped; the greater part Gros Michel from the dying fields; there were only 71,080 Congos. In 1912 the acreage was greatly extended; the greater part of the old Gros Michel fields were replanted with Congos. Unfortunately there was a heavy drought from September 1911 till April 1912, so that it lasted a very long time before the crop could be harvested. In 1912, 371,137 bunches were shipped, from which number in November 30,000 were delivered; the last shipment, December 28, 1912, amounted to 28,000.

"The greater part of the fields are planted with bananas and coffee, rubber or cacao; the banana is considered a catch-crop, which lasts about three years. In December 1910, when the greater part of the fields were attacked by

the disease, the Dutch Government resolved not to give any more advances for the banana business under the old conditions. So the contract with the United Fruit Company had to be broken, but the company declared itself inclined to buy up the fruit for a short time to see if the Congo was fit for export. During this period a steamer would be sent only thrice in four weeks.

"In October 1912 the United Fruit Company informed the Government that it would not take the Congo any longer because it was not marketable. The Government and the company entered into negotiations with the preliminary result that the company will buy bunches till May 16, 1913, by a two-weekly service.

"The Congo banana does not grow as high as the Gros Michel; I think the largest stems are about 8-10 ft.; as a rule the stem hangs a little to one side, so that *every* stem must be propped; this is a disadvantage as compared with the Gros Michel. However, it is an advantage that the stem is not so high, as harvesting of the bunches is easier in this variety. The usual distance is about 14 ft.; but the distance depends also upon the trees planted between the bananas, either coffee or cacao, and sometimes rubber. Ripe bunches may be harvested in nine months after planting; the main crop comes after ten to eleven months. The bunches of the first crop are not very big, the average size is the eight-hand bunch; the second crop gives the fine big bunches, often ten and more hands. The bunch, however, is not so regular as the Gros Michel; particularly there is often a great distance between the first, second, and third hands. The hands contain a large number of fingers. As I have already stated, the Congo is immune against the disease; after the first cases no more have been reported. The great trouble in the fruit is that it does not ripen regularly; sometimes the skin is still green and the pulp already soft; some fingers are also sometimes ripe long before the other part of the bunch. The fingers look like those of the Gros Michel; the colour is not such a nice yellow; they taste a little sweeter, and have not the same

flavour. The irregular ripening of the fingers seems to be one of the reasons why the United Fruit Company will not buy the fruit. The prices paid here are the same as for the other variety, the average per annum and per bunch being 51.5 cents (Dutch currency). The average weight of a nine-hand bunch is about 62 lbs., of an eight-hand bunch about 52 lbs., and of a seven-hand bunch about 40 lbs. The keeping qualities are not so good as those of the Gros Michel; it does not last so long, but still it keeps during the voyage to New York. (Paramaribo to New York takes ten days.)

“ Bananas are not only exported as fresh fruit, but there is also a manufactory for drying bananas in this colony. This industry has just begun to develop; dried bananas are exported to be eaten as banana figs (especially to Germany), but also, more strongly dried, to be used as banana flour. In 1911 the value of the export amounted to about £1300.”

The Commission appointed by the Government of British Guiana to inquire into the industry in Surinam with the view of starting a similar one at home, made a Report from which the following information * is taken: The soil of the estates in Surinam varies from a very fertile, moderately stiff clay loam to a rich, friable sandy loam—two contiguous fields often showing marked differences in agricultural value. The more loamy and friable the nature of the soil, the easier it is of cultivation and the more vigorous is the growth of the bananas, and the heavier, more tenacious soils produce less healthy growth of the plants and fewer and smaller bunches of bananas. The average yield was very small in 1909, sixty-six to ninety bunches per acre. This was due chiefly to disease, as of a total area of 8000 acres under bananas, practically 3000 were destroyed by disease, and the damage done to other estates was equivalent to the product of at least another 1000 acres. On one estate where an average of 203 bunches per acre was obtained during its first year,

* *Journ. B. Agric., B. Guiana*, iv. 204 (1911).

the average was reduced to eighty-five bunches per acre. The Panama and Surinam diseases are the chief trouble, but great damage has been caused by bees, and also by wind in exposed situations.

In 1910 the size of the bunches fell off * considerably; the contributing causes have been disease, faulty cultivation, too close planting, and insufficient drainage. The importance of good and careful cultivation, of at least 4 ft. good drainage, and of not planting closer than 16 ft. by 16 ft. was particularly noticeable in the Surinam cultivations, and growers who attempted planting closely, not cultivating, or not attending to drainage, only obtained poor results.

COLOMBIA.—The United States Consul at Barranquilla stated in his Report for 1906: "The banana industry has developed wonderfully, and although yet in its infancy, it is by far the greatest industry in the district, the output having increased from 171,891 bunches in 1892—the first year of any recorded export—to 1,397,388 bunches in 1906. The present area devoted to bananas is about 7000 acres, of which an American corporation owns 25 per cent., the balance belonging to individuals. All the fruit is purchased and exported by the American company. For climatic and geological reasons, Santa Marta cannot be said to be a banana country, such, for example, as Costa Rica. Irrigation has to be carried out here during at least seven months in the year; the lands also require drainage, and the winds often cause serious damage to the crop, but labour is cheap, averaging 50 c. per day, and very good results are obtained. These results, indeed, compare favourably with those of Costa Rica, where winds are practically unknown, and rainfall is plentiful all the year round, but where labour is dear, averaging \$1.00 a day. Jamaican labourers are alone available on the Costa Rica plantations, whereas native labour is used almost exclusively in Santa Marta, and is proving satisfactory. The total amount of banana land conveniently situated for irrigation in the

* *Journ. B. Agric., B. Guiana*, iv. 19 (1910).

whole district or Santa Marta, including Rio Frio and Fundcion, might possibly reach 50,000 acres, but it is very deficient in transportation facilities, and these must be provided before development can be brought about." Since 1906, very great progress has been made in every way, much of the available land has been planted and the means of communication improved—a railway having been opened.

During the year 1911 a steady advance was maintained, 22,000 acres being planted, and considerable irrigation works being brought into operation. The steamers engaged in this trade are of 5000 tons and specially built for the purpose. The Santa Marta Railway, a British enterprise, is fifty-eight miles in length with some thirty miles of branch lines for banana service, this fruit representing about 80 per cent. of the traffic of the line. The number of bunches exported in 1910 reached a total of 4,370,883, and in 1911 of 4,901,894. The following table shows the weight and value of bananas exported to United Kingdom and United States during 1911 :

	Kilos.		Value in £
United Kingdom .	54,083,722	..	233,807
United States .	56,270,592	..	200,144
	<hr/>		<hr/>
Total .	110,354,314	..	433,951

CHAPTER XXX

GENERAL REVIEW OF CULTIVATION—*continued*

CENTRAL AMERICA AND UNITED STATES

COSTA RICA.—The total area under bananas at the end of 1911 was 65,000 acres, new plantations to about 2500 acres being made during the year. The United Fruit Company are carrying out extensive improvements in the cultivation of many of their older plantations. The exports of bunches of bananas for certain years from 1882 to 1911 have been as follows :

1882 . . .	3,500	1909 . . .	9,365,690
1892 . . .	1,178,812	1910 . . .	9,097,285
1902 . . .	4,174,199	1911 . . .	9,309,586
1908 . . .	10,060,009		

The bunches exported in 1910 and 1911 were shipped as follows :

To	1910	1911
United States	8,000,249	7,217,148
United Kingdom	1,097,036	2,092,438

According to its favourable position, or otherwise, the cost of an acre of land in forest in Costa Rica may vary from 2*s.* 6*d.* to about £5. It costs about £8 per acre to clear it, and put it into condition to raise bananas. The soil seems rich enough to stand continuous cultivation, wherever it receives a sedimentary deposit from the overflowing of the rivers, but the usual duration of a plantation on land which is not overflowed is from seven to ten years. It is expected to yield twelve to fifteen bunches of bananas per acre every month. The vegetation is so rank, and its

growth so rapid, that it takes one man to every three acres to clear the brush and grass every four months, pick the fruit, dig the ditches, build the bridges, and do all the necessary work. Farm labourers are paid from 85 c. to \$1.50 per day, American money; they can live luxuriously on these wages, if they choose. Each bunch of bananas costs, it is calculated, about 4*d.* for cultivation, cutting, and carrying to the railway station, and is sold there for about 1*s.*

The plantations of the United Fruit Company are situated along rivers, canals, and railways. The estates along the rivers are flooded two or three times a year, and a yearly deposit of 5 or 6 in. of alluvium is left. The sub-soil is gravelly. The banana plants are put in at a distance of 20 to 30 ft. in the rows, and the rows are 15 ft. apart.

It is said that the fruit trade in this republic commenced with the export of a few bananas by a German, named Frank, who was in the service of a steamship plying between Panama and New York. The large return induced him to give up the steamer in 1863, and he devoted himself henceforth to the culture and export of the banana. At the end of ten years' work, however, the difficulties had been so great that he was no better off than when he began. But he then obtained certain facilities, which enabled him to establish a trade, and seven years later he retired with a fortune. In 1880 the Government, foreseeing that the cultivation would prove a great source of revenue to the country, offered large tracts of land to planters who would undertake to grow bananas. In 1882 3500 bunches were exported, and the development of the trade dates from that year. In 1888 there were sixty-one large and a great number of small plantations. In 1902 a monthly service of steamers was established by Messrs. Elders and Fyffes from Limon to Bristol and Manchester. The service to England soon became a weekly one, while there are at least three weekly sailings to the United States. The rate of wages to labourers in the banana district is nearly 3*s.* daily, as compared with an average of 1*s.* 8*d.*

on the coffee plantations. An export duty of one cent per bunch is now charged.

The outlet for the banana is Port Limon on the Caribbean. To tap the banana districts, the main line of railroad, leased and operated by the United Fruit Company under the name of the Costa Rican Northern Railroad, extends from Port Limon to San José, the capital, 103 miles distant, and 5000 ft. above the sea. From the main line extend a number of branches, and from the branches other spurs and tramways, the whole forming a system of veins and arteries for the transportation of bananas. Every effort is made to get the bananas from the trees to the ship as soon as possible and with the minimum handling. The main line is a common carrier of both passengers and freight. At Port Limon the company has built a number of steel piers from which the ships are loaded with bananas and coffee by special machinery. The company has large offices in Port Limon, and has in addition a wireless station, a hospital, quarters for its employés, light and power plants, and wholesale and retail stores. The Government receives a direct as well as an indirect revenue from the fruit company through an export tax of one cent gold upon each bunch of bananas sent out of Costa Rica. The big banana-growing districts practically end in the foothills of the mountain range which divides Costa Rica, and where bananas stop coffee begins.

The company has developed other activities, which include railroads, stores, telegraph and telephone systems, light and power plants, hospitals, schools, and various forms of agriculture and stock-raising.

Another company has begun to operate in the country to the north of Port Limon.

PANAMA.—Bananas are the chief export, other exports being insignificant in amount and value. The entire export of bananas comes from the plantations of the United Fruit Company at Bocas del Toro, and amounted to 3,643,900 bunches, valued at £184,257, in 1910, and to 4,297,260 bunches, valued at £214,835, in 1911.

NICARAGUA.—The first shipment, consisting of about 500 bunches, was made in the latter part of 1883, the fruit being sold at the vessel's side at the rate of 50 cents (Nicaraguan currency) per bunch. The success that attended this first attempt induced many persons, including several foreigners, to commence the cultivation of bananas, and in five years the whole of both banks of the Rama river, commencing from about twenty miles from the Bluefields Lagoon up to the junction of the rivers Escondido and Sequia, and such parts of the last-named rivers as are navigable for canoes, had been cleared and cultivated. In 1883, the number of bunches exported was 8000 ; in 1887, 255,332 bunches ; in 1903, 2,000,000 bunches ; in 1910, 490,000 of the value of £22,090 ; and in 1911, 2,250,000 bunches—all going to the United States. Important as is the export trade, the home consumption is of much more importance, for next to corn (maize), plantains and bananas form the principal sustenance of the natives.

GUATEMALA.—About a quarter of a century ago, the establishment of lines of steamers between New Orleans and Livingstone, and the bounty offered by the Government, stimulated the planting of many small *fincas* along the shores and on the river-banks. Under contract with the steamship companies, the planter sold his bananas at 50 cents a bunch (of not less than eight hands) during five months of the year, and for 37½ cents the rest of the year. The cost of production was calculated at 12½ cents per bunch (United States currency). Plantains were realizing at the same time 25 cents a bunch of twenty-five, sometimes as much as \$1 25 c. per 100 fruits. The export is still small ; in 1909 it was 765,223 bunches, valued at £45,911, which were shipped from Livingstone and Puerto Barrios to the United States. A large increase in the export is expected in view of the large extent of new land being brought under cultivation by the United Fruit Company in the valley of the Lower Motagua near Puerto Barrios.

The estimated production for the year 1910 was 1,225,684 bunches, valued at £70,000.

The number of bunches exported in 1911 was 1,755,704.

BRITISH HONDURAS.—The suckers are put out at 18 ft. by 18 ft. This wide planting is claimed to be ultimately advantageous in producing fine large bunches as well as in affording space for the cultivation of cacao, rubber and other plants of a more permanent character. When suckers are produced, all except two or three of the strongest are destroyed; this is done by bending them down, and it is said that a cutlass should not be used, as cutting them down bleeds them, and consequently takes away the strength of those left.

Plantains have been grown and exported to the Southern United States from British Honduras, Guatemala, and the Mosquito Coast, and they are much appreciated as an article of food. They can be packed loosely instead of in bunches as in the case of bananas, and the money value on the cultivation is said to be much larger than on bananas—the returns on plantains in Guatemala being at the rate of \$144 per acre as against \$106 on bananas.

The exports from 1906 to 1911 are as follows :

	Bananas—Bunches		Plantains—Numbers
1908 . .	471,600	..	939,000
1909 . .	390,350	..	2,238,500
1910 . .	441,181	..	3,514,101
1911 . .	450,365	..	2,853,445

The value of the bananas exported in 1911 was \$93,392, and of the plantains \$23,206. In Honduras, planters prefer to grow plantains to bananas—as they are much hardier and less likely to be rejected at the ship's side.

HONDURAS.—The chief culture is that of bananas, mostly on the Atlantic coast; the exports were in 1907–08 of the value of £160,106, in 1908–09 of £185,400. The Consular Report for 1910 states that bananas form over 40 per cent. of the total export trade of Honduras. Only an infinitesimal proportion of its lands has as yet been planted. These are all situated on the north or Atlantic coast and form a strip of some 100 miles wide along the coast. Up till quite recently the whole of the crop has

been shipped exclusively to New Orleans and Mobile, but an attempt is being made to establish a line between Honduras, Colon, and Southampton, in order to supply the British markets. The exports for 1911 were estimated at 6,500,000 bunches.

MEXICO.—The climatic conditions* of Southern Mexico are admirably suited to banana cultivation, while the various streams and small rivers that occur provide facilities for transportation of the fruit to the coast. Under these circumstances the Mexican banana industry is becoming more important each year.

The cost of land in the republic suitable for the cultivation is from £10 to £15 per acre, and it is stated that the cost of clearing and making ready for planting amounts to an additional £40 to £50 per acre.

In growing bananas on the commercial scale, about 200 hills are allowed per acre, and there are four suckers to each hill. It is arranged, however, that these suckers are in different stages of development, the oldest bearing fruit, and the youngest just coming forth from the ground.

In an article dealing with the whole question of banana growing in Mexico that appeared in *Tropical America*, there is given a tabular statement showing the average yield and net profit obtained per acre by growers of the fruit in the chief banana-producing countries. According to this, a yield of 290 bunches per acre, giving a net profit of \$68.75, may be expected in Mexico. Honduras comes second with a return of \$66.84 per acre, while in Jamaica the net profit from banana growing is placed at \$58.97 per acre.

In the district round Tampico, according to the British Consul,† banana growing has proved a profitable industry, and with a view to export, planters have imported suckers from Jamaica in preference to cultivating native Mexican kinds.

The banana grows to great perfection in many parts. In the state of Tabasco banana cultivation has assumed considerable importance in recent years. There is a

* *Agric. News*, 1908.

† Report for 1907.

regular service of steamers engaged in this trade between Frontera and Galveston, Texas. All the bananas imported into Galveston are from Mexico ; in 1909 they were of the value of £5579, and in 1910 of the value of £10,584.

The number of bunches exported in 1911 was estimated at 750,000.

UNITED STATES.—In the United States, according to E. N. Reasoner,* there is little commercial cultivation of bananas, since the frostless zone is narrow and the fruit can be grown so much more cheaply in Central America and the West Indies. Small banana plantations are common in Southern Florida, however, and even as far north as Jacksonville. They are also grown in extreme Southern Louisiana, and south-westward to the Pacific coast. The plants will endure a slight frost without injury. A frost of 5° or 6° will kill the leaves, but if the plants are nearly full grown at the time, new foliage may appear and fruit may form. If the entire top is killed, new suckers will spring up and bear fruit the following year.

“In the Gulf States, just outside the tropics, the banana,” according to the *Kew Bulletin*, “is often grown, although fruit is not expected more than once in four or five years. It is met with in the open air (in sheltered gardens), from Southern Texas to South Carolina. In Florida its culture for profit is not carried on farther north than Putnam county, and even in parts of South Florida there are few large patches, though nearly every one has a few plants. The fruit is generally inferior in quality, as compared with tropical fruit. Often, as in the severe frost of 1886, all the banana plants in Florida are killed to the ground. In the exceptionally mild climate of California in N. lat. 34° (corresponding to that of Cyprus) bananas have ripened in the open air, as, for instance, at Tustin in Los Angeles county. The principal *Musa* grown in California is the ornamental Abyssinian banana (*M. Ensete*). This has produced seed from which plants are now growing in many parts of the State.”

* In “Cyclopedia of American Horticulture.”

CHAPTER XXXI

GENERAL REVIEW OF CULTIVATION—*concluded*

WEST INDIES AND BERMUDA

BARBADOS.—At the instance * of the Imperial Commissioner of Agriculture, a banana industry of moderate dimensions was started in Barbados in 1902, with a modest export of eighteen bunches, the variety favoured being the small or Canary banana, known as *Musa Cavendishii*, which, in its perfect state, commands such a good price as to justify the planters packing each bunch in a crate. In the following year 6669 bunches were shipped; but the shipments were looked upon as mainly experimental, and no monetary account was kept of the results. From 1904, however, a careful account was kept of the number of bananas shipped annually, and of the proceeds, and in that year 15,298 bunches were shipped, of which only 6·6 per cent. arrived in an unsaleable condition, while the average net amount paid to the shippers was 2s. 4½d. per bunch. In 1905, from the beginning of January to August 12, 21,898 bunches were shipped, and of these only 2·3 per cent. arrived in unsaleable condition, while the planters netted on the average 2s. 5¼d. per bunch. This, with trees planted 10 ft. apart, and 10 ft. apart in the rows, represented a very profitable return per acre, and great was the disappointment when the Royal Mail Steam Packet Company began to receive bananas in such quantities from Trinidad that all the cold storage space available was occupied by this fruit, and the bananas from Barbados had to be put in the ordinary holds, with the result that

* *West India Committee Circular*, Jan. 28, 1913.

nearly all of it rotted on the voyage. The consequence of this was that from October 1905 to March 1906 the 10,000 bunches shipped only realized an average of 2*d.* per bunch, while the cost of crates, packing, &c., amounted to 1*s.* 2*d.* per bunch, so that the planters, besides losing their bananas, lost 1*s.* on each bunch, the result being that they discontinued shipments and destroyed their plants. A meeting of the Barbados Agricultural Society was, however, held on January 5, 1913, under the chairmanship of Sir F. J. Clarke, President, to consider certain proposals received from the British West Indian Fruit Company, a concern closely allied with the Royal Mail Steam Packet Company, with a view to the resuscitation of the banana industry in the island. Mr. Bovell, the Superintendent of the Local Agricultural Department, who addressed the meeting, said that there was now ample cold storage accommodation in the Royal Mail Steam Packet Company's steamers, with the prospect in the near future of new and better steamers on the route. He further pointed out that the demand for the fruit was on the increase, and that, therefore, it would appear that the moment was opportune for reviving the business in Barbados. He added that the Fruit Company would be prepared to assist the planter in every possible way, and would favourably consider the question of advances to planters against bills of lading. As the outcome of negotiations, the British West Indian Fruit Company has informed the Local Agricultural Department that they hold the Royal Mail Steam Packet Company's undertaking to reserve space for 1000 crates in cold storage each mail for one year ending September 30, 1913, and space for 2000 crates for one year ending September 30, 1914, such reservation of space being subject to a guarantee from the shippers that the named quantities would be shipped or the freight paid. They further offered to advance to shippers 1*s.* 9*d.* for eight and nine hand bunches respectively, and to pay to the grower the balance on the sales, after deducting freight and handling charges and commission. The suggestion was

also made that each crate should be inspected before shipment, and a Government stamp placed upon it as evidence that the bunch weighed the number of pounds, or consisted of the number of hands, as stated by the shipper. It is confidently expected that a sufficient number of planters will be induced to re-embark upon the banana industry to enable a binding arrangement to be made.

PORTO RICO.—Messrs. Cook and Collins, in “Economic Plants of Porto Rico,” state that the banana is, perhaps, the most important food crop of the island, but that it is not regularly cultivated, only used as shade for coffee, and not exported. As shade is the chief point, and no fruit is exported, the Jamaican banana is scarcely known, as other varieties are considered better for local consumption. They suggest that one of the numerous varieties superior to that known in commerce should be planted so as to produce export quantities. “The value of the common sort lies in its shipping qualities, which result from the fact that it shares some of the attributes of the plantain in being of rather coarse texture, with a tough skin and a large quantity of mealy outer coating of the flesh, which gives the dry sensation, and, when not thoroughly ripened, the astringent taste. Really fine varieties are so superior in flavour and texture that, once regularly introduced into the trade, they would certainly secure the popular preference and command special prices.” Greater care would be required in shipping, but the returns on carefully packed good mangoes sent to England from Jamaica are so large that no doubt prices would pay handsomely for equal care given to the very best bananas. One requisite, however, is that the selected variety should be put on the market in such quantity as would justify fruit merchants in properly introducing it to the public. These notes suggested for the consideration of Porto Rico planters are most important and have been borne in mind for some years by those responsible for the Botanic Gardens in Jamaica. Efforts have been made there to form a large collection of varieties, and some of the planters have made

experiments with them. So far no great hopes have been raised, but the experiments should be continued and enlarged, other varieties from Porto Rico, Cuba, and other West Indian islands might be tried, as well as a more extensive collection from the East.

The *Annual Report* for 1907 of the Agricultural Experiment Station gives the following information about the experiments with bananas:

“The banana plantation is showing excellent growth and a number of the new varieties are now fruiting. These new types are being described and tested for their economic value.

“The chief and vital objection to the growing of bananas for export has been the fact that the bunches were too small. In Porto Rico a bunch with six or eight full hands is considered large. Whether this characteristic of small bunches is due to the variety, soil, or cultural methods is yet to be determined. The quality of the fruit is excellent, and the number of bunches produced on a given acreage is fairly large, so that if the size of the bunch could be increased, or more prolific varieties grown, bananas could well be raised for export.”

TRINIDAD.—Dr. de Verteuil thus described the three varieties of plantains in Trinidad: “The horn plantain, from the resemblance the fruit bears to the horn of a young bull, is more extensively cultivated than the other sorts, being hardier and not requiring frequent replanting; but though the fruit is much larger, whence it also obtains the *sobriquet* of horse plantain, its bunch is not so well supplied, having ordinarily but twenty-five, and often fewer, plantains or fingers to the bunch; as an edible it is also much coarser than the other species. *French* or *maid* plantain: the body of this plant is of a dark violet colour, as also the nerves of the leaves; the fruit is smaller than that of the former, but the bunch is supplied with a much greater number of plantain fingers, averaging about sixty to eighty, and sometimes 100 to 130. This species is regarded as more delicate than the others, particularly when ripe. *Dominica* plantain: this is a variety of the

latter; though the body is exactly like that of the *horn plantain*, the bunch resembles that of the *French*, but the fruit is somewhat shorter and plumper.

"The plantain," he says, "requires a good deep soil and a sheltered position. It is propagated by sprouts which are planted 10 ft. apart. From five to seven of the young shoots or suckers spring out of and around the parent stem. The fruit makes its appearance between eight, nine and twelve months. The young shoots then give their fruit in succession, for two, three, or even many years, according to the climate, fertility of the soil, and the care bestowed on them. A plantain walk requires only occasional weeding and pruning."

Mr. J. McInroy reports * on the experiments with the bananas in Trinidad: "The cultivation of Gros Michel had to be abandoned on account of disease, and a start was then made to ship Governors (*M. Cavendishii*) uncrated on consignment to the British West Indian Fruit Company at Southampton; this arrangement threw any loss on the shippers, but has been found to work satisfactorily, and with the improved carrying facilities of the Royal Mail steamers will, I think, continue so. If care is taken in the grade of fruit sent, and the fruit carefully handled, the difficulty in shipping the Governor variety may be overcome. This variety has more disease-resisting qualities than the Gros Michel, the yield per acre is heavier, and, owing to its short stumpy nature, it does not suffer from wind.

"The banana disease is still prevalent, but with the steps taken, I am hopeful that it can be successfully combated; fields that are attacked are partly abandoned, diseased trees cut down and limed, the beds banked up and stumps buried, the field afterwards planted with sweet potatoes, and after two crops of potatoes are reaped, the field is replanted with the Governor variety. Fields treated in this manner are comparatively free of disease. Two fields side by side originally planted in Gros Michel, which had

* *Bull. D  pt. Agric. Trin. and Tob.*, ix. 203 (1910).

died out from disease, were replanted with Governors ; one was treated as described, and the other was simply replanted ; the first shows scarcely any signs of disease, while the other has had to be banked and replanted.

“ From a field of Governors of five acres planted in 1904, which had received a dressing of 40-50 tons of pen manure per acre in 1908, the heavy return of 4596 stems was reaped or 919 per acre, and as our stems shipped for the past year netted the low average of $21\frac{1}{2}$ cents each on the market, even this small price will show a return of nearly \$200 per acre, while our average expenditure for the year was slightly under \$40 per acre.

“ Since the planting of the Gros Michel has been entirely substituted by the Governor variety, the yield per acre has very much increased. The Governor can be planted as close as 9 by 9 ft., or even closer, where a plentiful supply of pen manure can be had. Of late I have tried the rearing of cattle in open pens in the cultivation, and while the stock so penned show every sign of improvement, this very much lessens the cost of pen manure, and opens up a possibility of combining stock raising for the market in conjunction with the cultivation of bananas. . . . Twenty tons per acre of pen manure applied every second year supply the soil with sufficient plant food for the growing of bananas.”

Professor Carmody, Director of the Department of Agriculture, Trinidad, gave* the following information on bananas in Trinidad at the Agricultural Conference in 1912 : “ Bananas form the bulk of exported fruit. The cultivation has been hampered in various ways, but notwithstanding this the value of the exports has risen to about £20,000. Local experience has shown that for cultivation on a large scale the Canary banana (‘ Governor ’ banana) possesses many advantages over the Gros Michel, which was first tried here on account of its profitable cultivation in Jamaica and elsewhere. The Government has for several years made field experiments on a fairly

* *Bull. Dept. Agric. Trin. and Tob.*, xi. 19 (1912).

large scale at St. Augustine estate, and the results obtained are sufficiently encouraging to justify the Department in recommending the extension of the banana industry on the lines now adopted by the manager of St. Augustine estate.

“ . . . Manurial experiments with bananas are an important feature of the cultivation. It has been proved conclusively that heavy dressings of pen manure (40 tons per acre) are very beneficial and remunerative. Rough temporary pens are erected on the banana fields in order to reduce the cost of the manure, and, as the supply of pen manure is usually small in comparison with the area under cultivation, experiments with artificial manure, with and without a light dressing of pen manure, are being made.”

CUBA.—About 2,500,000 bunches of bananas were exported during 1911. The production of bananas is second in importance among the agricultural industries of Santiago de Cuba. There are three districts where bananas are grown for export: Saetia on Nipe Bay, Sagua de Tanamo on Tanamo Bay, and in the region about Baracoa. But there has been a large decrease in banana growing for export during the last few years, as the winters of Cuba are too cold and dry, and the fruit produced cannot compete with that from Jamaica and the Central American States. All the bananas produced are sent to the United States. There are several different kinds cultivated for local use; amongst these is the variety known as “Ciento a la boca,” with yellow pulp, sweet and pleasant to the taste, but the delicate skin renders it incapable of exportation. The varieties “Nino” and “Maukano” are also known in Porto Rico.

HISPANIOLA.*—Sloane says of the banana: “This tree was no native in the West Indies, but brought thither from the Canary Isles by one Thomas di Berlanga, a friar, to Santo Domingo in the year 1516, from whence they were sent to the other isles and Main, and they, being very useful and taking extremely, were planted every-

* This is the old name, and the most convenient one, for the island divided now between the Republics of Haiti and San Domingo.

where (Oviedo, lib. 8, cap. 1), but in all probability this plant came first from Guinea to the Canaries."

Acosta states that in San Domingo there is a small white variety of banana, very delicate, called *dominico*. The possibilities of San Domingo in fruit culture are entirely neglected, except in one single instance. This one exception is a large banana plantation at Sosua, about ten miles from Puerto Plata, owned by the United Fruit Company. The number of bunches exported in 1907 was 640,000, and in 1910 was 591,000; the number for 1911 is estimated at 400,000.

The consumption of banana flour is steadily increasing. The fruit is gathered green and cut into slices and then placed in the sun for three days in order to dry it thoroughly. Then it is ground, and yields an excellent fine yellow meal. Cooked in milk, it is eaten as a soup; and it is also made into bread. About ten bananas are required to furnish a pound of flour.

GUADELOUPE.—According to M. de Saumery, Guadeloupe has 10,000 acres suitable for the growth of the banana—the Jamaican for export to the United States, and the Chinese banana to Europe. The most suitable districts are Trois-Rivières, Capestone, Petit Bourg, Lamentin, and Sainte Rose.

DOMINICA.—The number of bunches of bananas exported from 1908 was as follows:

1908		1910		1911		1912
3295	..	4719	..	3713	..	5526

JAMAICA.—In the year 1867 the value of the fruit exported from Jamaica was only £728, and Sir John Peter Grant, in his annual report as Governor, complained that whereas in the Bahama Islands the fruit trade afforded an important staple of export in the article of pineapples alone, it was still neglected in Jamaica, although there was no place in the world more suited by nature for the production of exportable fruits of great market value. For several years the captains of small schooners sailing

between America and Jamaica had been in the habit of taking a few bunches of bananas back with them for consumption on their homeward voyage and for distribution among their friends. But as a trade it may be said to have commenced in the year 1869, when Captain Bush loaded seven vessels with bananas in Port Antonio. Mr. Kerr and Captain Baker were also two of the shippers of bananas in those early days of the trade, and it was due to the organizing genius of Captain Baker that the trade rose to such importance. Ten years after Captain Bush's venture (in 1879) the value of the bananas shipped was £32,895. By the end of the next ten years (1889), owing to a subsidy of £5000 granted by the Government to the Atlas Steamship Company, it had increased to a value of £252,114. At the end of the next ten years (1899) the value was £468,580.

The exports and their values from 1909 to 1912 have been as follows :

Year ended December 31	Stems	Value in £
1909 . . .	16,712,210 . . .	1,403,830
1910 . . .	14,095,191 . . .	1,141,710
1911 . . .	16,497,385 . . .	1,456,582
1912 . . .	13,382,072 . . .	1,241,187

Jamaica exported in 1911 nearly twice as many bananas as any other country, the export from Costa Rica coming next with 9,309,586 bunches.

During the fiscal year 1910-11 the value of the fruit exported was £1,624,245, being 58·5 per cent. of the value of the total exports. During this year exports of fruit of the value of £80,860 went to the United Kingdom, £1,509,437 went to the United States, £29,838 went to Canada, and £4110 went to other countries.

During the fiscal year 1911-12, 82,435 acres were under cultivation with bananas, as compared with 79,283 acres for 1910-11, an increase of 3152 acres, the average for the four years preceding 1911 being 67,573 acres—on which there is an increase of 14,862 acres. The acreage of estates varies from 20 to 500 and 600, besides hundreds of small

holdings comprising fewer than 20 acres. Taking the acreage for 1910-11 as being mature and all bearing fruit, and comparing this with exports for 1911, it appears that the number of exportable bunches produced per acre was 208 ; and comparing acreage with value, as given in the Government returns, the average gross yield for the island was over £18 per acre.

Banana Figs in Jamaica.—"Banana figs" have been prepared in Jamaica during the last few years with success which has varied according to the care and knowledge displayed in the preparation. An article is wanted that will give all the delicacy of flavour of the ripe fruit with inviting appearance and perfect keeping qualities. There are now eleven factories at work in Jamaica, but probably only those that turn out "figs" as described above will be able to continue. An inferior preparation damages not only the manufacturer, but the whole trade, and probably accounts in some measure for the present small demand. The export has fluctuated considerably, but has steadily increased to Germany and Holland.

Messrs. Gillespie Bros. and Co. write : " We are informed by one of the large buyers in Hamburg that he could place two or three hundred boxes of 56 lbs. each monthly at the price of about 42s. to 43s. per cwt. ex store Hamburg, but that if the quantity shipped from the West Indies or elsewhere were increased to any great extent, the price would rapidly decline, as only a certain quantity was at present required. The value of the article in the English market is not considered to be more than 35s. to 38s. per cwt., and the present demand is quite small, although it is possible that by extensive advertising the consumption might be considerably increased."

Among the exports from Jamaica in 1912-13 were 9389 packages of banana figs valued at £7808. As the factories use up the smaller bunches of fruit not suitable for export as fruit, and as some of them are located at places so distant from a seaport as to forbid the sale of fruit during the dull season, they appear to supply an urgent need.

FACORIES FOR MANUFACTURE OF BANANA FIGS IN OPERATION IN JAMAICA
IN NOVEMBER 1912

Parish	No.	Approximate Capable Output	Whether Produced Exported or Consumed	How Packed	Value F.O.B.
Kingston . . .	1	Just started	Will be exported	In cases of 56 lbs.	£30 to £36 a ton
Portland . . .	1	1 ton per week	Exported	In cases of 100 lbs. net	30s. per 100 lbs.
St. Mary . . .	1	3½ tons per week	"	In cases of 56 lbs. and 100 lbs. respectively	£27 per ton
Trelawny . . .	1	2 " "	"	In cases of 56 lbs.	£20 "
do. . .	1	½ ton per week	"	" "	£20 "
St. James . . .	1	½ " "	"	" "	£30 "
do. . .	1	2 tons per week	"	" "	£30 "
Westmoreland . . .	1	50 tons per annum	Consumed	" "	£30 "
Clarendon . . .	1	2½ tons per week	Exported	" "	£36 "
do. . .	1	2½ " "	"	" "	£36 "
do. . .	1	1½ " "	"	" "	£38 "

BANANA FIGS EXPORTED

	Jan. 1 to Dec. 31, 1911				Jan. 1 to Sept. 31, 1912			
	Pkgs.	£	s.	d.	Pkgs.	£	s.	d.
United Kingdom	330	444	5	6	10	5	0	0
U.S.A.	—	—	—	—	51	28	9	0
Canada	2		8	0	1		7	6
Germany	1055	729	6	9	3293	2661	13	0
France	—	—	—	—	10	18	0	0
Holland	27	31	5	0	408	316	3	3
Belgium	40	20	0	0	66	55	0	0

PRESERVES—NON-ENUMERATED

	Pkgs.				Pkgs.			
	£	s.	d.		£	s.	d.	
United Kingdom	387	400	16	6	115	178	16	0
U.S.A.	41	109	4	5	15	27	15	5
Canada	28	44	4	0	7	9	1	0
Germany	1463	1292	15	10	629	624	13	6

Varieties and Species under Cultivation.—The following is an alphabetical list of bananas that were growing in Hope Gardens in the year 1908: Almeida pisang, apple, champa, Chinese or Canary, cinerea (Saharanpur), discolor, guindy (Ootocamund), Jamaican, kudjo hudang pisang (Java), lady's finger, ditto from Panshanger, maas pisang (Java), martabanica, oleracea, palembang pisang, radji pisang, raja siem, ram kela (red or rubra), sereh pisang, susu pisang (Java), vittata, unnamed variety from the Congo from Mr. Patin, with dark red leaves.

BERMUDA.—The Superintendent of the Public Garden wrote in his Report for 1905 as follows: "The Canary Islands banana thrives exceedingly in Bermuda, probably better than in any other part of the world, including that part of China which is its native habitat. Its doing so well here is another instance of the peculiar effect of our unique climate upon certain plants. There are in Bermuda probably not more than thirty acres under bananas, planted and cultivated in a style that did very well when there was plenty of land and some to waste, but which would have to be replaced by more up-to-date methods if the banana became an article of export. Planted ten feet by eight feet apart and given even less care than is bestowed upon potatoes, an acre of bananas could be made to yield in Bermuda quite 2,000 bunches per annum."

CHAPTER XXXII

HORTICULTURAL AND BOTANICAL NOTES : CULTIVATION OF SPECIES OF MUSA

SPECIES of *Musa* are cultivated in cool climates wherever there are large glass hothouses suitable for their growth. The Abyssinian banana (*Musa Ensete*), and also *Musa basjoo*, will succeed even in cool houses ; they form noble objects in the Temperate House at Kew. Tropical kinds require great heat all the year through. The Palm House at Kew contains a large collection of esteemed kinds, whence they are distributed from time to time to tropical institutions in the Colonies. Chatsworth has the distinction of being the origin of all the "Chinese" bananas now growing in Fiji and Polynesia ; the scientific name of this species (*M. Cavendishii*) is therefore quite appropriate. Sion House and Panshanger Gardens are also well known for successful cultivation of these interesting plants.

Mr. W. Watson, Curator of Kew Gardens,* gives the following account of the treatment of bananas at Kew : " A selection of edible-fruited Musas is cultivated in the Palm House at Kew, in addition to the collection of about twenty species represented in the various houses. With scarcely an exception they are all easy to cultivate ; they like rich soil, a fair allowance of root-room, plenty of sunlight, and liberal supplies of water. The deciduous species, represented by *M. superba*, are kept quite dry during winter. *M. Cavendishii* does not fruit as well in the Palm House as it does at Sion House and in other gardens, but all the forms of *M. sapientum* fruit well at

* *Bull. Misc. Inf., R. Gard., Kew*, 1894, 280.

Kew. They are planted either in large tubs or in a border on the south-east side of the house in a compost of rich loam and cow manure. Suckers about 6 ft. high, when planted singly, fruit in from two to three years. The bunches are cut as soon as the fruit shows signs of changing from green to yellow, and hung in a warm room to ripen. This they do in about a fortnight after cutting. Fruit ripened on the plants is not nearly so rich in flavour as when it is cut and ripened in a room ; it also ripens much more slowly if left on the plants. As soon as a bunch is cut, the stem which bore it is cut off level with the ground, and a sucker, of which there are generally several in various stages of growth, is selected to take its place. Travellers who have tasted some of the best of the Kew-grown bananas say that they are superior in flavour to what are obtainable in the tropics."

The late Mr. G. Nicholson, when Curator of Kew Gardens, wrote as follows * on the cultivation of Musas in hothouses :

"Musas are handsome foliage plants, available for culture in large pots or tubs when required to be movable, or they may be permanently planted in houses which afford sufficient heat and space for their development. Some of the hardier species, under the first-named treatment, may be utilized for sub-tropical gardening outside in summer. *M. Ensete* and *M. superba* are two of the best and hardiest for the purpose. A sheltered position is necessary, the leaves being so soon torn by rough wind. *M. coccinea*, a dwarf-growing slender species with a brightly coloured inflorescence, may be grown well in 10 in. pots for winter decoration of tropical houses. Musas require a strong loamy soil, with plenty of manure added, and almost any amount of heat and moisture may be given in summer. In winter a resting season should be allowed, water being almost, or in some cases entirely, withheld. Propagation may be effected by seeds, sown in heat, during spring ; and most of the species produce suckers, which

* " Dictionary of Gardening."

also afford a ready method of increase. The plants are sometimes cultivated for their fruits, but not extensively, on account of the great space and the amount of heat required. *M. Cavendishii* is the most compact-growing species for this purpose, and the one which is perhaps the most certain to succeed. Strong suckers must be obtained to start with, and grown on in pots until established. They should then be planted in a prepared bed of very rich soil, and encouraged to grow vigorously by maintaining a high temperature and humid atmosphere. The time taken in growing plants to fruiting size varies considerably according to the treatment given in cultivation."

A writer in *Gardeners' Chronicle* gives his experience as follows :

"There are few plants of so noble an appearance as the *Musa*, the massive leaves being almost unequalled for size in the vegetable kingdom. A stately plant of banana has few rivals for effect in the sub-tropical garden, and specimens are cultivated in many gardens in temperate climates for associating with palms and other fine-leaved exotics in the ornamental grounds in summer-time. Banana fruits are now imported in such great numbers that they form one of the most popular of fruits, not excepting the apple or the orange. But few have enjoyed the exquisite flavour and soft melting flesh of a hothouse-grown specimen, as it is only occasionally that bananas are grown for their fruits which can be had in perfection at any season of the year. A home-grown banana is a useful addition to the rather limited number of dessert fruits obtainable during the early months of the year, and is to be preferred to a second-rate peach, nectarine, or pear. When grown under suitable conditions and properly matured on the plant, they are far superior to the imported fruits. The Chinese banana, *Musa Cavendishii*, is the best for fruiting purposes. A glasshouse with an internal height of about 12 ft. will accommodate the tallest plants of this species. The temperature of the house in winter should be maintained at 60° to 70°, and in summer-time from

70° to 80°. The plants can be either grown in large tubs or in borders. The soil should consist of a good strong loam with sufficient sand to keep it porous, and some coarse bonemeal well mixed together. Plants grown in tubs require an abundance of water and food as the banana is a gross feeder. They need some kind of artificial manure about every ten days, as soon as they become root-bound. Water must be given in abundance at all stages of their growth, otherwise the bunches of fruit will be stunted and not set well. It usually takes from thirteen to fifteen months from the rooted suckers before the inflorescence begins to push from the centre of the plant. When the bunches of fruit, which frequently weigh from 50 lbs. to 70 lbs., are forming, they will require supporting by cord attached to the rafters, and another five months are required to develop the fruits, making in all from eighteen to twenty months before they are perfected. During the last month it is advisable to limit the amount of manure and water. As soon as the fruits turn yellow they should be removed from the plant, otherwise the skins crack and spoil the appearance. One large house would produce fruits at all seasons, provided successional plants were grown. A slight shading during the hottest weather is better than excessive ventilation. The syringe must be used frequently to keep red spider in check, but too much water must not be allowed to reach the heart of the plants, or the fruits will be liable to rot. Thrips sometimes attack the plants and spoil the appearance of the fruits ; because of this an occasional fumigation of the house is necessary."

CHAPTER XXXIII

PLANTS ALLIED TO THE BANANA

THE nearest genera to *Musa* are *Ravenala*, *Strelitzia*, and *Heliconia*. The plants belonging to these three genera are not of the same vast importance as the banana and plantain, but they are remarkable for their noble form and foliage, and are of value therefore from a horticultural point of view.

Ravenala madagascariensis is the Traveller's Tree of Madagascar, probably so called on account of the water stored up in the long hollow leaf-stalks. The leaves are of somewhat the same shape as those of the banana, but larger, and are arranged in one plane, like a gigantic fan at the top of the stem; they are used for thatching in their native country. The seeds are edible, and the blue pulpy aril which surrounds them yields an essential oil. The only other species, *R. guianensis*, a native of Guiana, is not so well known. Both species are well worth cultivation.

The species of *Strelitzia* are natives of South Africa; they are large perennial herbaceous plants, most of them with curious and gorgeous flowers, called "bird of paradise flowers." "The flowers remind one of those of the iris family, and consist of six segments, the three outer usually of a brilliant orange colour (white in *S. augusta*), while the three inner are unequal, the two lower ones united, forming an arrow-headlike hood, of a rich purple colour, and concealing in a slit or fold the five perfect stamens and an imperfect one. These fine flowering and foliage plants are much hardier than is generally supposed, and well deserve more general culture. Numerous beautiful seminal varie-

ties, which, if not actually true hybrids, are of equal practical importance, have been raised in Belgian gardens.”*

S. augusta is a noble plant, 10 ft. high, with white calyx and petals.

S. farinosa is 4 ft. high with purple and yellow flowers.

S. nicolai is a superb plant, growing to a height of 25 ft., with whitish calyx and blue petals ; the spathes green and purplish, growing to as long as $1\frac{1}{2}$ ft. It is considered by some to be only a variety of *S. augusta*.

S. reginæ is the most magnificent species of the genus, although it is only 5 ft. high. The flowers are orange and purple, large, and produced in great abundance.

S. parvifolia juncea is 4 ft. high, with purple and yellow flowers, but the blade of the leaf is wanting, or is reduced to narrow margins ; the leaf-stalks resemble the stems of large rushes.

Heliconia is nearly allied to *Musa*, and *H. bihai* is recognized as a “wild plantain” by the natives of the West Indies and South America, where it grows wild. This species is a grand and striking foliage plant, well worth cultivating, and it is known now throughout the tropics. It is cultivated in the open in South Florida and along the Gulf of Mexico ; and even when killed by frost, it readily springs again from its strong root-stock. Being often 15 ft. high, it requires a large house when cultivated in hot-houses in temperate climates. The flower-sheaths are very large, scarlet-coloured ; the flowers are red or orange. The form *aureo-striata* is very handsome ; the leaves are beautifully striped along the midrib and veins with yellow, the stems are also striped with yellow. Another form, *illustris*, is like the last, but the midrib and veins are marked with pink. The form *rubricaulis* has more red, the leaf-stalk being bright vermilion.

The genus differs from *Musa* chiefly in the arrangement of the flowers, and in the dry, three-celled, three-seeded fruit.

By studying flowers belonging to these genera, especially

* “Cultivated Plants.” By F. W. Burbidge. 1877.

Ravenala and *Heliconia*, the structure of the flowers in *Musa* is more easily understood. In *Ravenala* (Traveller's Tree) the sepals and petals are free from one another, and somewhat similar, except that one petal is shorter than the other two. In *Heliconia* (Wild Plantain) two of the sepals are more or less adherent to the two united petals, just as occurs to a much greater degree in *Musa*.

The flowers in the three related genera are simpler and are hermaphrodite, whereas in *Musa* they are functionally unisexual. In *Ravenala* there are three free subequal sepals ; three petals, of which the two lateral are similar to the sepals but a little shorter, and the third, the median, is slightly shorter than the lateral ; five stamens ; a three-celled ovary ; stigma six-toothed ; capsule loculicidally three-valved, with numerous seeds in each cell. In *Strelitzia* there are three free sepals ; three petals, of which the median is very short and free, the two lateral are long, with the adjacent edges cohering, surrounding the stamens and pistil ; five stamens ; ovary three-celled ; stigma with three linear branches ; capsule loculicidally three-valved, with a few seeds in each cell. In *Heliconia* the three sepals are free from just above the base, sometimes the lateral are more or less adnate to the corolla ; the corolla is composed of one long composite portion, similar to the sepals but with two or three lobes at apex, and of another odd petal, relatively very short ; stamens five perfect, with a staminode more or less petaloid ; ovary three-celled with one ovule in each cell ; stigma toothed. Fruit indehiscent three-celled, or sometimes with one or two cells only. Seeds solitary in the cells.

CHAPTER XXXIV

SHORT DESCRIPTION OF SPECIES OF MUSA

It may be useful to some cultivators to have a handy list of all the known species of *Musa*, with short descriptions and indications of their value. These may possibly be sufficient to enable them to identify any unnamed kind. Reference may be made for fuller information to Baker's paper in "Annals of Botany," vii. 205 (1893), to the *Kew Bulletin* for 1894, and to Schumann in Engler's *Pflanzenreich* iv. (1900). All new species, not included in the above, have a reference to the original descriptions appended to the name. The terms made use of in the descriptions are those used in the explanation of the flowering system of the banana in Chapter I.

SUBDIVISIONS OF THE GENUS MUSA

I. Subgenus *Eumusa*. Trunk cylindrical. Flowers many to a bract. Free petal ovate-acuminate. Bracts green, brown, or dull violet. Fruit usually edible.

II. Subgenus *Rhodochlamys*. Trunk cylindrical. Flowers few to a bract. Free petal linear. Bracts bright-coloured, often red. Fruit usually not edible.

III. Subgenus *Physocaulis*. Trunk bottle - shaped. Flowers many to a bract. Free petal usually tricuspidate. Fruit not edible.

I. SPECIES OF SUBGENUS EUMUSA : 1 TO 27

1. *M. sapientum* L. Trunk to 20 or 25 ft. high, suckering. Leaves oblong, green, 5-8 ft. long, $1\frac{1}{2}$ -2 ft. broad,

usually rounded at the base. Inflorescence drooping, often 4–5 ft. long. Male flowers deciduous. Bracts dull violet, more or less glaucous outside, the lower 1–1½ ft. long, the upper ½ ft.; often red inside, several expanded at once, the edges of the upper not involute. Free petal nearly half as long as perianth. Fruit somewhat three-angled, 3–8 in. long, yellow, eaten uncooked or cooked. “Banana.”

Subspecies *M. paradisiaca* L. Male flowers and bracts less deciduous. Fruit cylindrical, ½–1 ft. long, with firmer and less saccharine pulp, eaten cooked. “Plantain.”

Subspecies *M. seminifera* Lour. Fruits small, oblong, full of seeds, not edible, yellowish or greenish. This apparently represents the wild seed-bearing form; it extends in a wild state from Behar and the eastern Himalayas to the Malay and Philippine Islands.

Subspecies *M. troglodytarum* L. Inflorescence erect in lower half and drooping in upper half. Fruits small, crowded on the lower erect portion, oblong-round, reddish yellow, containing rudimentary seeds; flesh sweet, yellow. Wild in India, Ceylon, and the Malay islands; the favourite food of elephants.

2. *M. acuminata* Colla. Leaves 5–6 ft. long, glaucous beneath, triangular at the base. Inflorescence drooping. Male flowers deciduous. Bracts violet, only one of those of the female flowers opened at once and revolute, those of the male clusters involute at the edge. Free petal nearly as long as the perianth. Fruits in four to six clusters of 10–12 each, oblong, beaked, 2–4 in. long, 1–1½ in. in diameter; skin not easily peeled off, flesh sweet. Seeds dull black, angled by pressure, ⅙ in. in diameter. Common in Java and the other Malay islands, extending eastward to New Guinea. Kurz says that a large proportion of the bananas which are cultivated in the Malay Archipelago are derived from it, and that its best varieties are superior to all those derived from *M. sapientum* in quality and delicacy. The typical *M. acuminata* is wild, and has fruits full of seed. From

this several seedless cultivated varieties are immediately derived, differing in the colour of the leaves and fruit. They all have the leaves glaucous beneath, and in one form the waxy bloom is so copious that torches are made from it. The cultivated variety is much larger in all its parts, with much larger flowers and longer cylindrical or angled yellow or greenish seedless fruits. Of this there are forty-eight distinguishable varieties, of which the most curious is the duck plantain, the fruit of which has a beak nearly as long as its body.

3. *M. corniculata* Lour. Trunk 10–12 ft. long. Leaves 5–6 ft. long. Inflorescence drooping; only the lower two or three bracts and flower-clusters are developed. Free petal nearly as long as the deeply toothed perianth. Fruit cylindrical, a foot or more long, $1\frac{1}{2}$ – $2\frac{1}{2}$ in. in diameter, golden yellow; skin thick; pulp reddish white, firm, dry, sweet, very palatable when cooked. Malay islands and Cochin China. The fruit has been compared to a cucumber as regards shape and size. The Lubang variety produces only a single fruit, large enough for a full meal for three men.

4. *M. Cavendishii* Paxt. Whole plant 4–6 ft. high. Trunk 2–3 ft. long, suckering. Leaves 6–8 very close together, spreading, 2–3 ft. long, much rounded at the base, rather glaucous; stalk short, deeply channelled. Inflorescence dense, short, drooping. Bracts red-brown or dark; male flowers and their bracts persistent. Perianth yellowish white, an inch long, with five obtuse lobes; free petal about half as long. Fruits as many as 200 to 250 in the bunch, oblong, six-angled, slightly curved, 4–5 in long, above $1\frac{1}{2}$ in. in diameter; seedless, edible, with a rather thick skin and delicate fragrant flesh. Southern China.

5. *M. nana* Lour. Trunk 5 ft. long. Leaves 3 ft. long. Inflorescence short, recurved. Flowers all fertile. Fruit ovate-oblong, seedless, edible. Cochin China. It may be only a form of *M. Cavendishii*.

6. *M. lasiocarpa* Franchet. Whole plant 1–2 ft. high.

Trunk wanting. Rhizome covered with successive frills of the lower persistent leaf-sheaths. Leaves about 1 ft. long. Inflorescence under 1 ft. long, erect, dense. Fruit hairy, oblong, three-angled. Seeds 4-6 in each cell. Rocks in mountains of Yunnan, China, 4000 ft. altitude. "Rock banana."

7. *M. glauca* Roxb. Trunk 10-12 ft. long, 6-8 in. in diameter, not suckering. Leaves 4-5 ft. long, pale and glaucous, shortly stalked. Inflorescence drooping from the base. Perianth about 1 in. long, with three loosely coherent, linear segments. Free petal small, three-cuspidate. Fruit oblong, 4-5 in. long, $1\frac{1}{2}$ in. in diameter. Seeds smooth, globose, nearly black, $\frac{1}{2}$ in. in diameter. Pegu.

8. *M. Nagensium* Prain (*Journ. Asiat. Soc. Beng.* lxxiii. 2, p. 22, 1904). Trunk 20 ft. and more, suckering. Leaves 10 ft. long, glaucous beneath. Inflorescence drooping. Bracts oblong-lanceolate, lower 8-10 in. long, 4 in. broad, uppermost 6-7 in. long, nearly 3 in. broad, "Indian red" outside, bright shining orange inside, each enclosing 18-20 flowers in two rows. Perianth orange-coloured, $2\frac{1}{2}$ in. long, $\frac{1}{2}$ in. broad, four-lobed; free petal ovate-lanceolate, over 1 in. long, acute. Fruit angled, 5-6 in. long, stalked, not recurved. Seeds nearly $\frac{1}{2}$ in. long, $\frac{1}{3}$ in. broad. Naga Mountains, Assam.

9. *M. Wilsonii* Tutcher (*Gard. Chron.*, 1902, pt. 2, 450). Plant 10-12 ft. high. Trunk conical, 5 ft. long to lowest leaves, 15-16 in. in diameter at base. Leaves, including stalk, 10-12 ft. long by 2-2 $\frac{2}{3}$ ft. broad. Inflorescence drooping, 3 ft. long, 15 in. in diameter at base, 4-5 in. at apex. Bracts, all persistent, lower 1 ft. long, lanceolate, upper much shorter, ovate, at first green, becoming brown. Flowers 15-20 in two rows. Perianth nearly 2 in. long, three-lobed; free petal short, three-cuspidate, with a large linear central cusp. Fruit with sweet pulp, $3\frac{1}{2}$ -4 $\frac{1}{2}$ in. long, nearly $1\frac{1}{2}$ in. broad at apex but narrowing much to base, yellow. Seeds about twenty, black, about $\frac{1}{2}$ in. in diameter. "Elephant's Head." Yunnan, China.

"Cultivated for the inner portion of the trunk, which is used as food." Near *M. glauca*.

10. *M. discolor* Horan. Trunk slender, 6–10 ft. long, suckering. Leaves narrow-oblong, smaller and firmer in texture than in the banana, glaucous, tinged with red or violet beneath when young. Inflorescence drooping; bracts reddish, the upper only persisting; male flowers deciduous. Fruit cylindrical, angled, rather curved, rather dry, reddish violet, very palatable, with a violet pulp with a rather musky scent. Wild in New Caledonia (native name Colabonte), yielding textile fibre, which is used for fish-baskets, &c. It is widely spread in cultivation.

11. *M. Basjoo* Baker. Trunk 6–9 ft. long, 6–8 in. in diameter, suckering. Leaves 6–9 ft. long, $1\frac{1}{2}$ –2 ft. broad. Inflorescence 1– $1\frac{1}{2}$ ft. long. Perianth whitish, 2 in. long, free petal nearly as long. Fruit oblong, three-angled, 3 in. long. Liu Kiu Archipelago and cultivated in Southern Japan for its fibre. It is as hardy as *M. Ensete*.

12. *M. Martini* (Rev. Hort. Belg.). Has the habit of the banana with bright rose-red flowers. Leaves firm in texture, bright green above, glaucous beneath, with reddish veins. Said to be more hardy than *M. Ensete*. Brought from the Canary Islands.

13. *M. textilis* Née. Plant attaining a height of 13–22 ft., suckering. Leaves smaller and firmer in texture than in the banana, with large brown spots, rather glaucous beneath. Inflorescence drooping, shorter than the leaves. Male flowers deciduous. Perianth five-lobed, about $1\frac{1}{2}$ in. long, the outer lobes with a thread-like horn near apex, obscurely three-angled, curved, 2–3 in. long, 1 in. in diameter, not edible, but filled with seed. Seeds black, $\frac{1}{8}$ in. in diameter.

Variety *M. amboinensis* Miquel. Not so tall and inflorescence not so drooping. Fruit as long as a man's finger, black at maturity. Philippine Islands, where it is called "Abaca," and is used in the manufacture of Manila hemp.

14. *M. Tikap* Warb. Very near *M. textilis*, but with

a larger, straighter fruit, with greyish pulp and blackish-brown larger seeds. Caroline Islands. Origin of the native hemp.

15. *M. Bakeri* Hook f. Trunk 10 ft. high, 8-10 in. in diameter, suckering. Leaves 7 ft. long, 2 ft. broad. Inflorescence drooping. Bracts reddish brown and glaucous outside, bright crimson on inside. Male flowers 9-12 in a cluster in two rows. Perianth $1\frac{1}{2}$ in. long, five-toothed, teeth hooded at tip, two outer with an erect horn as long as the tooth ; free petal half as long, three-lobed, cuspidate at apex. Cochin China.

16. *M. flava* Ridley. Nearly allied to *M. malaccensis*, but the broad, thick, blunt, bright yellow bracts give it a totally different appearance, the spike being quite blunt at the top. Eastern coast of the Malay Peninsula.

17. *M. tomentosa* Warb. ex K. Schum. Stalk of the inflorescence covered with greyish-brown minute velvety hairs. Perianth $1\frac{1}{2}$ in. long ; free petal $\frac{3}{4}$ in. long, broadly ovate, cuspidate-acuminate. Fruit about 5 in. long, beaked, somewhat angled, with a short thick stalk. Celebes.

18. *M. celebica* Warb. ex K. Schum. Like the preceding, but fruit not beaked.

19. *M. lanceolata* Warb. ex K. Schum. Perianth nearly $1\frac{1}{2}$ in. long, exterior lobes horned ; free petal nearly 1 in. long, apex obtuse or truncate or mucronulate. Bracts ovate-roundish. Native of Celebes.

20. *M. Pierrei* Hubert (*Le Bananier*, p. 14, 1907). Trunk reddish. Inflorescence erect. Flowers mostly sterile. Fruits five, ovoid, in a single cluster. Habitat not stated.

21. *M. Harmandii* Hubert (*Le Bananier*, p. 14, 1907) Trunk short, reddish, sap violet. Inflorescence erect. Fruits perpendicular to the stalk. Habitat not stated.

22. *M. Hillii* F. Muell. Thirty feet high, not suckering. Leaves 12-15 ft. long, 2 ft. broad. Inflorescence erect. Fruits densely crowded, ovoid, not edible, much angled, 2-2 $\frac{1}{2}$ in. long, without a stalk. Seeds numerous. Queensland.

23. *M. Fitzalani* F. Muell. Trunk 20 ft. long. Leaves 10–12 ft. long, 2 ft. broad. Inflorescence drooping. Fruits oblong, angled, not pulpy, 2–3 in. long, with a stalk $\frac{1}{2}$ in. long. Seeds numerous. Queensland.

24. *M. Banksii* F. Muell. Trunk and leaf like those of the banana, suckering. Leaves 5–6 ft. long, $1\frac{1}{2}$ –2 ft. broad. Inflorescence drooping. Fruits quite cylindrical when dry, without any angle, straight, with a stalk $1\frac{1}{2}$ –2 in. long. Seeds grey, almost globular, $\frac{1}{8}$ in. in diameter. Queensland. This species yields a fibre of poor quality.

25. *M. fehi* Vieill. Trunk 15–20 ft. long, greenish, full of violet juice, suckering. Leaves larger and firmer in texture than in the banana and plantain, with stouter veins. Inflorescence long, erect. Perianth split at length nearly to the base. Fruits many in a bunch, oblong, angled, 5–6 in. long by above 1 in. in diameter, nearly straight, yellow when ripe, with a thick skin and moderately firm pulp, not very palatable when raw, but excellent when cooked. Seeds small, black. Common in the forests of Tahiti, where it is largely used for food ; seedless at low levels, but bearing seeds at an altitude of 3000–3600 ft. Native name “Fei.” Also found in New Caledonia.

26. *M. malaccensis* Ridley. Trunk slender, 6 in. in diameter, with purple-brown blotches. Leaves about 8 ft. long, green with brown bars. Inflorescence drooping, clothed with brown hairs. Bracts lanceolate, brown, glaucous outside, striped with yellow on the inside. Fruit 4 in. long. Seeds black, angular. Malay Peninsula. Ridley is of the opinion that “this species may perhaps be the parent of some of the cultivated bananas in the Peninsula, but is very distinct from *M. sapientum* in the hairy rhachis, &c. An attempt has been made to utilize the fibre. The plant is very abundant and springs up like a weed when old jungle is felled, and forms an impenetrable thicket.”

M. zebrina Flore des Serres (leaves with broad, irregular blotches of bronzy red and purple) is, according to Ridley, a young plant either of *M. malaccensis* or of *M. sumatrana*.

27. *M. hirta* Becc. (*Nelle Foreste di Borneo*, 622). Inflorescence erect, densely hairy. Bracts of male flowers obovate-lanceolate, acuminate; male flowers 8–10, in two rows under each bract; perianth five-toothed at apex, the two lateral teeth apiculate; free petal of same length as perianth; fruit about 2 in. long, covered with bristly yellow hair; seeds small, numerous, about $\frac{1}{8}$ in. in diameter, irregularly globose. Sarawak, Borneo.

II. SPECIES OF SUBGENUS RHODOCHLAMYS:

28 TO 44

28. *M. maculata* Jacq. Trunk slender, 7–8 ft. long. Leaves glaucous beneath, $2\frac{1}{2}$ ft. long, 6–8 in. broad. Inflorescence drooping from above the base; male flowers deciduous; spathes yellowish brown, the upper oblong, 3–4 in. long; flowers about four in a cluster. Perianth yellowish white, above 1 in. long; free petal nearly as long. Fruit oblong, 2–3 in. long, 1 in. in diameter, yellow spotted with brown, edible, aromatic; flesh white. Cultivated in Mauritius and Bourbon, where it is called “Figue mignonne.” Differs from other species of this section by its edible fruit.

29. *M. rosacea* Jacq. Trunk 3 to 5 ft. long, 3–4 in. in diameter, suckering. Leaves 3 ft. long, under 1 ft. broad, tinged with purple underneath; stalk long and slender. Inflorescence drooping or erect, 1 ft. long when mature; bracts pale blue or reddish lilac, the lower 6–8 in. long. Perianth yellow. Fruit 2–3 in. long, but little pulpy, scarcely edible. Seeds $\frac{1}{8}$ in. in diameter, black, tubercled, rarely produced in the cultivated plant. Eastern Himalayas and hills of the Concan.

30. *M. sumatrana* Becc. Allied to the previous species. Whole plant 7–8 ft. long. Leaves 5–6 ft. long, $1\frac{1}{2}$ ft. broad, glaucous, with irregular blotches of claret brown. Padang, Sumatra, 1100 ft. altitude.

31. *M. microcarpa* Becc. (*Nelle Foreste di Borneo*, 623). Plant smaller than the common banana. Inflorescence

drooping. Bracts of male flowers ovate-lanceolate, obtuse. Male flowers, about six, in two rows under each bract. Perianth five-lobed at apex, lobes lanceolate-linear, revolute, the two outer mucronate-appendiculate near apex; free petal very much shorter. Fruit about 3 in. long. Seeds numerous, irregularly lens-shaped, about $\frac{1}{6}$ in. in diameter. Sarawak. Related to the previous species.

32. *M. salaccensis* Zolling. Allied to *M. rosacea*. Leaves green on both sides, 2 ft. long. Inflorescence drooping, 1 ft. long. Flowers greenish. Bracts pale lilac, upper 2-3 in. long. Fruit full of brown seeds, 3 in. long. Mountains of Java and Sumatra.

33. *M. coccinea* Andr. Trunk 4-5 ft. long, 2-3 in. in diameter, suckering. Leaves 2-3 ft. long. Inflorescence erect, about 1 ft. long. Bracts of a brilliant scarlet, tipped with yellow, the lower $\frac{1}{2}$ ft. long. Flowers yellow, 1 in. or more long. Free petal nearly as long as perianth. Fruit oblong, three-angled, 2 in. long. Seeds very small, rarely produced in cultivation. Southern China and Cochin China. Yields a fibre of poor quality. This species is very ornamental.

34. *M. rosea* (Herb. Hort. Bot. Calcut.). Habit of *M. coccinea*. Leaves 1 ft. long, $\frac{1}{2}$ ft. broad. Bracts pale red, lower $\frac{1}{2}$ ft. long. Free petal as long as the perianth.

35. *M. rubra* Wall. Habit of *M. coccinea*. Leaves $1\frac{1}{2}$ -2 ft. long, 6-9 in. broad at middle. Bracts bright red, lower 1 ft. long. Free petal half as long as the perianth. Fruits dry, $1\frac{1}{2}$ -2 in. long. Rangoon, Pegu.

36. *M. angcorensis* Gagnep. (*Bull. Soc. bot. de France*, liv. 412, 1907). Plant 4-5 ft. high. Leaves narrowed to both ends, $1\frac{1}{2}$ -2 ft. long. Inflorescence erect, stalk pubescent. Bracts pale red, each enclosing about three flowers. Perianth four-toothed, $1\frac{1}{2}$ in. long; free petal oval, obtuse, one-fourth as long as perianth. Angcor, Cambodia, Indo-China.

37. *M. sanguinea* Hook. f. Trunk 3-5 ft. high. Leaves 2-3 ft. long. Inflorescence erect or, when mature, drooping. Bracts blood-red, lower $\frac{1}{2}$ ft. long. Perianth bright

yellow, $1\frac{1}{2}$ in. long. Free petal nearly as long as the perianth. Fruit oblong, three-angled, 2 in. long, rather pulpy, pale yellow-green variegated with red. Seeds small, black, tubercled. Assam.

38. *M. assamica* (Hort. Bull.). This is an elegant dwarf plant, well suited for table decoration. Trunk about $1\frac{1}{2}$ ft. high. Leaves about 1 ft. long, crowded, running out into a slender tendril-like point, green with a narrow purple border. Assam. Allied to *M. sanguinea*.

39. *M. Mannii* Wendl. Trunk 2 ft. long, 1 in. in diameter. Leaves few, spreading, 2– $2\frac{1}{2}$ ft. long. Inflorescence erect, $\frac{1}{2}$ ft. long. Female flowers in three clusters of three flowers each, their bracts deciduous. Male bracts crowded, pale crimson, 3–4 in. long. Perianth pale yellow, $1\frac{1}{2}$ in. long. Free petal much shorter. Assam.

40. *M. aurantiaca* Mann. Habit of *M. sanguinea*, but forming larger clumps of rather shorter stems. Bracts bright orange-yellow, lowest 1 ft. long. Fruit green, glabrous. Upper Assam.

41. *M. velutina* Wendl. and Drude. Habit of *M. sanguinea*, but differs from it and from *M. aurantiaca* by its velvety, bright red fruit. Inflorescence erect, with purple stalk. Flowers yellow, those below densely velvety. Assam.

42. *M. violascens* Ridley. Trunk slender, 8–10 ft. high. Inflorescence erect or almost erect. Bracts narrowly lanceolate, white tinged with purple-violet or wholly violet, 9 in. long. Flowers few, in single rows under each bract. Fruit green, 3 in. long by 2 in. wide. Seeds cylindrical.

43. *M. campestris* Becc. (*Nelle Foreste di Borneo*, 622). Leaves more erect than in banana, narrowing very much at base and running into the stalk. Inflorescence erect. Bracts of male flowers oval, acuminate. Male flowers about $1\frac{1}{2}$ in. long, perianth five-toothed, the two exterior lobes cuspidate; free petal $\frac{3}{4}$ as long as perianth, with rounded or emarginate apex. Fruit 3– $3\frac{1}{2}$ in. long by 1 in. broad. 3–4 ribbed, with a short, thick beak. Seeds

numerous, about $\frac{1}{4}$ in. long, brown, rough with tubercles. Sarawak. Related to *M. violascens*.

44. *M. borneensis* Becc. (*Nelle Foreste di Borneo*, 622). Very like the common banana in size and general appearance. Inflorescence pendulous. Flowers 5–8 in one row. Male flowers about 3 in. long; perianth gradually narrowing to the three-lobed apex, lateral lobes slenderly cuspidate; free petal $\frac{3}{4}$ as long as perianth, shortly acute. Fruit about 6 in. long by about $1\frac{1}{2}$ broad. Seeds obpiriform, nearly $\frac{1}{2}$ in. long, rough-tuberculate in the upper half. Sarawak. Belongs on account of single row of flowers to the section *Rhodochlamys*, but is not nearly related to any of the species.

III. SPECIES OF SUBGENUS PHYSOCAULIS : 45 to 66

45. *M. Ensete* Gmel. Whole plant 30–40 ft high. Trunk rises to a height of 13 to 20 ft., not suckering. Leaves bright green with a bright crimson midrib, 20 ft. long, 3 ft. broad. Inflorescence erect. Bracts 9–12 in. long, densely overlapping, ovate, dark claret brown. Flowers whitish, more than twenty in a cluster. Perianth $1\frac{1}{2}$ –2 in. long, three-lobed; free petal short, three-lobed. Fruit dry, 2–3 in. long. Seeds 1–4, black, glossy, nearly 1 in. broad. Mountains of Abyssinia southward to hills south of Lake Victoria Nyanza. Native name “Ensete.” It was discovered by the traveller Bruce, and is represented on ancient Egyptian sculptures. The flowering spike, before it has emerged, is much used as food by the Gallas and other tribes; also the young heads. It is the most hardy of all the cultivated species, growing freely in the open air in the Mediterranean region. This species is well adapted for sub-tropical countries, such as California, Florida, Algeria, and Canary Islands, and is often put out for the summer in the London parks. When established in sheltered situations, it is a very ornamental plant, having a noble and majestic habit.

46. *M. Holstii* K. Schum. (*Engl. Jahrb.*, xxxiv. 121,

1905). Plant three or four times as high as a man. Leaves 16 ft. long by 3 ft., and more, broad. Inflorescence very large, drooping. Upper bracts covering the male flowers, long persistent. Male flowers, about $\frac{1}{2}$ in. long, stalked; perianth more or less deeply three-lobed, lobes linear, hooded at apex; free petal with three or sometimes five lobes, the middle lobe oval-shaped, lateral toothed. Fruit pear-shaped, about 4 in. long by 2 in. broad. Seeds very large, about $\frac{3}{4}$ in. broad. West Usambara. Near *M. Ensete*.

47. *M. fecunda* Stapf (*Journ. Linn. Soc.*, xxxvii. p. 528, 1906). Trunk 2 ft. in diameter at base. Inflorescence drooping. Bracts lanceolate-oblong, subacuminate, about $1\frac{1}{3}$ ft. long and 5 in. broad. Flowers very numerous. Perianth linear-oblong, apex obtuse three-toothed, 2 in. long, with two awl-shaped strips on the inside, nearly 1 in. long; free petal three-lobed, about $\frac{3}{4}$ in. long, the median lobe awl-shaped, lateral lobes rounded. Fruits very numerous (418 counted in one bunch). Seeds, a little over $\frac{1}{2}$ in. in diameter, flattened-globular. Uganda, 5000 ft. altitude.

48. *M. Perrierii* Claverie (*Comptes Rendus Acad. Sc. Paris*, cxi. p. 1612, 1905). Plant to 20 ft. high; trunk $2\frac{1}{2}$ ft. in diameter at base. Inflorescence drooping. Bracts oval, varying in colour—green, yellow, rose, violet. Flowers 18–20 under each bract. Free petal three-lobed, median lobe acute, lateral lobes rounded. Stamens five perfect and one abortive. Fruits very numerous (210 counted on one bunch), 4 or 5 in. long and about 1 in. thick; pulp yellowish, forming a thin layer. Seeds numerous, black, irregularly ovoid, $\frac{1}{3}$ in. in diameter.

49. *M. ulugurensis* Warb. and Moritz (*Tropenpflanzer*, viii. p. 116, with figures, 1904). Plant over 20 ft. high. Trunk about 2 ft. in diameter at base. Leaves 16 ft. long. Inflorescence drooping. Female flowers (before opening) 6 in. long. Perianth (not yet open) 2 in. long, divided nearly to the base into three obtuse lobes with two linear strips on the inside alternating with the lobes and about as long;

free petal about $\frac{1}{2}$ in. long, with broad wings which form lateral lobes at the apex, the median lobe long cuspidate. Fruits 100-150, forming a spherical conglomeration, each fruit about 4 in. long, 2 in. thick. Seeds black, 10-20, about $\frac{3}{4}$ in. long, $\frac{1}{2}$ in. broad, embedded in the pulp. Male flowers and bracts deciduous. Uluguru, German East Africa.

50. *M. nepalensis* Wall. Trunk 5 or 6 ft. high, cone-shaped, 2 ft. in diameter at base. Like *M. superba*, but leaves narrower, somewhat glaucous, and without stalks, passing gradually into bracts. Inflorescence short, showy, clavate, drooping. Bracts large, ovate, many-flowered, dull purple. Flowers in two rows, 7-8 to a bract. Perianth yellowish white, three-cleft; free petal obcordate with a large mucro shorter than the calyx. Fruit and seeds as in *M. superba*.

51. *M. ventricosa* Welw. Whole plant 8-10 ft. high. Trunk 4 ft. in diameter at base, not suckering. Leaves of thick texture, 4-5 ft. long, bright green with a pale red midrib. Inflorescence drooping. Perianth entire, not cuspidate. Free petal entire, $\frac{1}{3}$ in. long. Seeds large, angular. Angola.

52. *M. Buchananii* Baker. Nearly allied to *M. Ensete*, but the bracts are linear-oblong, 1-1 $\frac{1}{2}$ ft. long. Flowers ten in a cluster. Shiré Highlands.

53. *M. Davyæ* Stapf. (in *Kew Bulletin*, 1913, p. 103). Trunk 30-40 ft. high. Leaves 12-17 ft. long. Bracts oblong, about 1 ft. long and 5 in. broad. Flowers about 15 to each bract. Perianth about 1 in. long, linear, the two petals not united in the middle; free petal less than half as long, three-lobed. Fruit 3-5 in. long, yellow; pulp scanty. Seeds few, greyish brown. Transvaal and Portuguese East Africa. Fruit not edible, but fibre used by the natives.

54. *M. Livingstoniana* Kirk. Trunk conical, twice the height of a man, 2-3 ft. in diameter at base. Leaves crowded, as long as the trunk. Fruit 4 in. long, many-seeded. Eastern tropical Africa from 12° to 19° south latitude, ascending to 7000 ft. altitude.

55. *M. proboscidea* Oliver. Trunk 4-5 times as high as a man. Leaves very large. Inflorescence finally drooping, nearly as long as the trunk. Free petal very short, with two orbicular outer lobes and a large linear central cusp. Seeds $\frac{1}{2}$ in. long and broad. Hills of Ukami, 100 miles inland from Zanzibar, German East Africa.

56. *M. superba* Roxb. Whole plant reaching a height of 10-12 ft. Trunk 7-8 ft. in circumference at the base, narrowed to 3 ft. below the leaves. Leaves 5 ft. long. Inflorescence at first globose, a foot in diameter, finally drooping, a third the length of the trunk; bracts orbicular, dull claret-brown, attaining a foot in length and breadth. Perianth 1 in. long, whitish, formed of three loosely cohering segments. Free petal short, three-cuspidate, with a long linear, central cusp. Fruit 3 in. long. Seeds very numerous, $\frac{1}{3}$ - $\frac{1}{2}$ in. in diameter, brown. Western Ghats of the Bombay Peninsula. Yields a poor fibre.

57. *M. Schweinfurthii* K. Schum. and Warb. Trunk not very inflated at base. Leaves 7 to 8 ft. long, 15 in. broad. Inflorescence drooping. Bracts ovate-lanceolate, about 1 ft. long by $3\frac{1}{2}$ in. broad. Perianth to 2 in. long, entire, not cuspidate; free petal entire. Seeds small, somewhat globular. Niam-Niam, Central Africa.

58. *M. Chevalierii* Gagnep. (*Bull. Soc. bot. France*, iv. 87, 1908). Plant 13 ft. high. Trunk $1\frac{1}{2}$ ft. at base, leafy throughout. Leaves 6 ft. long, 12-16 in. broad, stalk purplish at base, narrowed in middle, pruinose-glaucous outside. Inflorescence drooping, with very crowded fruit, remainder of stalk with male flowers. Bracts ovate-lanceolate, 16-5 in. long by $8-1\frac{1}{2}$ in. broad. Perianth $1\frac{1}{4}$ in. long, three-toothed, teeth semi-orbicular; free petal half as long, two-toothed, teeth obtuse. Fruit club-shaped, green with white dots and yellowish pulp. Seeds about thirty, black. Oubangi and Chari, tropical Africa. Near *M. Schweinfurthii*.

59. *M. elephantorum* K. Schum. and Warb. Trunk 24 ft. long, leafy from base upwards. Leaves 7-9 ft. long

2½ ft. broad. Inflorescence erect. Perianth entire, to 2 in. long; free petal nearly ¾ in. long, apiculate or cuspidate. Seeds small, somewhat globose. Cameroon.

60. *M. Gilletii* De Wild. (*Rev. Cult. Colon.*, viii. 102, 1901). Plant 5–8 ft. high, not suckering. Leaves about 5 ft. long. Inflorescence drooping, short. Flowers five to six in each row. Free petal three-toothed, nearly ½ in. long. Fruit about 2 in. long. Seeds nine or ten, about ⅓ in. long. Congo Free State. Seeds used as a fetish.

61. *M. religiosa* Dybowski (*Rev. hort.*, 1900). Forming a true bulb like *M. Gilletii*, but differing in having roots from the whole surface of the bulb instead of from the top of the bulb only, as occurs in *M. Gilletii*. The seeds are of a grey colour, not black. After germination and growth for a few months all the leaves die down, and it is found that a bulb has been formed, which, after a period of rest, starts again into growth, whereas in *M. Gilletii* the leaves do not die down. The flowers have not been described. The fruit is full of seeds and is not edible. The plant is considered a fetish by the natives of the French Congo, where it is indigenous.

62. *M. Homblei* Bequaert ex De Wildeman (*Les Bananiers*, 51, 1913). Plant 2½–3½ ft. high, not suckering, trunk more or less swollen at the base. Leaves at the middle of the trunk have, instead of a stalk, a sheath, about 8 in. long, which in its lower two-thirds is closely applied to the trunk halfway round it, the upper third bends out horizontally and passes into the blade of the leaf, which is about 5 in. long, oblong-lanceolate; the leaves gradually change in character upwards, the limb becoming reduced and the sheath relatively longer but less and less applied to the trunk, passing into bracts. Inflorescence drooping or horizontal, 5 in. long. Bracts numerous, persistent, longer than the inflorescence. Flowers at base hermaphrodite, upper male, 1¼–3 in. long, generally five or six in one row, but towards the middle of the stalk with one or two on the outside. Perianth three-lobed; free petal shorter, three-toothed, middle tooth long, mucronate. Fruit about 1½ in.

long, 1 in. broad, becoming blackish, pulp scanty, yellow. Seeds ovoid, black, $\frac{1}{4}$ in. long, $\frac{1}{3}$ in. broad. Katanga. Found only at the base of the white ant hills.

63. *M. Arnoldiana* De Wild. (*Bull. Soc. Etud. Colon. Brux.*, viii. 339, 1901). Plant 12 to 15 ft. high, not suckering. Leaves 7 ft. long. Inflorescence drooping, short. Flowers three to seven in each row. Free petal three-toothed, about $\frac{2}{3}$ in. long. Fruit nearly 4 in. long. Seeds 12-16, about $\frac{1}{2}$ in. long. Congo Free State. Seeds used as a fetish.

64. *M. Laurentii* De Wild. (*Miss. Laurent*, 371, t. 130 and figures 61, 62). Leaves with a green midrib. Bracts 14 in. long, $4\frac{1}{2}$ in. broad, elliptical, narrowing towards apex. Perianth three-lobed, $1\frac{1}{4}$ - $1\frac{1}{2}$ in. long; free petal rather more than $\frac{1}{2}$ in. long, rounded at apex with awn-like mucro. Flowers 18-23 in two rows under each bract, nine to thirteen on the inner row, and nine to ten on the outer row. Fruit 4-5 in. long. Stanleyville, Congo.

65. *M. Bagshawei* Rendle and Greves (*Journ. Bot.*, xlviii. 169, t. 506, 1910). Plant 16 to 18 ft. high. Trunk $6\frac{1}{2}$ ft. in circumference 6 in. above the ground. Leaves with a narrow red edging and red midrib, $11\frac{1}{2}$ ft. long. Inflorescence drooping, $2\frac{1}{2}$ ft. long. Bracts dull red, acuminate, 11 in. long, 6 in. broad. Flowers 17-19, in two rows, under each bract. Perianth three-lobed, about $1\frac{1}{2}$ in. long; free petal three-toothed, median tooth awn-like, lateral rounded, rather more than $\frac{1}{2}$ in. long. Fruit light orange with a little darker pulp, $4\frac{1}{2}$ -5 in. long. Seeds thirty, black, shining. Uganda. Very near to *M. Laurentii*.

66. *M. gigantea* Kuntze. Plant nearly 30 ft. high, not suckering. Inflorescence 10 ft. long. Bracts green, ovate-oblong. Flowers white, 20-40 to each bract. Fruit 2 in. long, angled. Seeds very small.

M. Brownii F. v. Muell, quoted by *Pucci in Bollet. Soc. Tose. Ort.*, 1906, p. 296, and *M. imperialis* Hort. Vilmorin, p. 299 of same vol., are without description. The former has been referred to the section *Rhodochlamys* and the latter to *Physocaulis*.

M. sylvestris Lemarié (*Bull. écon. de l'Indo-Chine*, 1901).

This is a name given to a wild banana, indigenous in Haut-Tonkin, recommended as a fibre plant. No description has been published.

FOSSIL PLANTS ASCRIBED TO MUSA

Lesquereux describes a fossil plant from the North American Tertiaries which he names *Musa complicatum*. Schimper has named a form from the Miocene of Bohemia *Musa bilanicum*. Saporta describes, from the Eocene of Aix and Italy, plants which he calls *Musa speciosum* and *M. longævum*. These are only known from the leaves, which exhibit a form of venation characteristic of the living forms.

APPENDIX

RECIPES FOR COOKING BANANAS

TO COOK BANANAS

TAKE thoroughly ripe, juicy bananas, the riper the better, large ones preferred.

Provide two or three to each person. Cut off the ends, peel them and split them lengthways and remove the strings. Have ready a clean frying-pan, into which place a lump of the best fresh butter the size of a large walnut. When the butter is melted put in the fruit, flat side up, cover close with a plate which fits the frying-pan. Cook over a *very* slow fire, and prevent them sticking to the pan by carefully passing a knife under each, so as not to break them if possible.

Add a little more butter from time to time, to prevent burning. When quite soft, remove the plate and fry to a golden brown.

Time, 30 to 40 minutes to cook them properly.

Be sure not to put water on them.

Bananas thus cooked, besides being very economical, possess all the essential elements which constitute a most nourishing, hygienic food, especially as a breakfast dish for children, when eaten with bread.

BAKED BANANAS

Select large and not over-ripe bananas for this dish. Strip off about a third of the skin lengthways, and loosen the remainder of skin from the fruit by means of a teaspoon.

Lay the bananas in a buttered saucepan or baking-dish, place a few very tiny bits of butter on top of each, and besprinkle freely with castor sugar. Pour over each about $\frac{1}{2}$ teaspoonful of lemon juice and bake for 15 or 20 minutes in a hot oven.

GRILLED BANANAS

Take 6 or 8 ripe bananas, wipe them, put them under the grill or over a bright fire, cook for 10 or 15 minutes. Serve hot in skins in hot dish. Very good for breakfast, especially in winter. Serve with lemon juice.

BANANA TART

Take a large deep dish such as used for apple tart, $1\frac{1}{2}$ dozen of bananas cut in rounds, half the grated rind of 1 lemon, the juice of 1 lemon, 3 oz. moist sugar, a teacupful of water. Pastry same as for apple tart. Bake in a moderate oven for about 20 minutes.

BANANAS FRIED IN EGG AND CRUMBS

Remove skins from 10 or 12 bananas, brush egg over each, cover with bread-crumbs and fry in hot fat.

This may be served as a savoury or sweet.

For Sweet.—Serve with sugar, lemon syrup, or jam sauce.

For a Savoury.—Sift the following mixture over the banana before coating with eggs and crumbs and also before serving:

One teaspoonful of salt, $\frac{1}{4}$ teaspoonful of dry mustard, $\frac{1}{4}$ teaspoonful of pepper, a little cayenne, and 1 teaspoonful of red or brown crumbs. Mix well together and shake over the bananas.

BANANA CUSTARD PUDDING

Half fill a pie-dish with sliced ripe bananas, and sprinkle with a good brown or castor sugar. Make a pint of custard (or cornflour) in a saucepan, sweeten to taste, and pour over the bananas ; add a few tiny mites of butter, grate a little nutmeg over the whole, and bake in the oven for half an hour. Serve with cream.

BANANA PRINCESS PUDDING

Take 6 bananas, the whites of 2 eggs, a little apricot jam, a little castor sugar.

Peel and mash the bananas, and put into a greased pie-dish and add a layer of apricot jam and let it get warm through in a moderate oven. While that is cooking, take the 2 eggs and separate the whites from the yolks. Whip the whites with the castor sugar until it is quite stiff. Then put it on to the pudding, return to the oven, and bake until a golden brown. (This will take about 5 minutes.) To be served hot or cold.

This may be decorated with glacé cherries and angelica.

BANANA WHIP

Peel 6 ripe bananas, mash them up with a fork, put the pulp into a saucepan with a gill of water, 2 oz. of castor sugar, the thinly cut rind and juice of $\frac{1}{2}$ lemon, and cook gently over the fire for about 10 minutes. Stir in the stiffly whisked white of an egg, and continue to cook for another 5 minutes ; then let cool, remove the lemon rind, and whisk in 1 gill of cream (stiffly whipped).

Fill up custard glasses, or pour the preparation in a glass dish, and keep on ice till required. Then serve with wafers or finger biscuits.

THE PANAMA DISEASE OF BANANAS, OR BANANA WILT

AN important paper by Dr. E. W. Brandes was published in *Phytopathology*, September, 1919, recording his investigations, and the results obtained, with regard to the "Panama disease" of bananas, which he prefers to call "banana wilt." Selections from this paper were published in the *Agricultural News* for February 21, March 6, and March 20, 1920.

After referring to the importance of banana cultivation in Central America and the West Indies, Dr. Brandes describes briefly the methods of cultivation. He then alludes to the variation in the ability of the disease to attack different varieties of bananas. It is a curious fact that, in any particular region, this disease attacks most severely, and sometimes exclusively, the variety which is there most esteemed, and therefore most widely planted. It is also interesting to note that varieties which are strongly attacked in one country appear to be resistant in another, although the disease may be present in great abundance on some other variety.

The reasons given for preferring the name "banana wilt," as applied to this disease, in place of "Panama disease" are stated to be—(1) that the disease is by no means confined to Panama, but is widespread in the American tropics; and (2) that it is very similar both in symptoms and in identity to the causal organism of the well-known "cotton wilt," "okra wilt," "tomato wilt," etc., and therefore the name "banana wilt" is in accordance with the best usage among plant pathologists.

It was in Panama and Costa Rica that the disease first attracted wide attention on account of its destructive

nature, having attained alarming proportions in those countries by 1904.

Dr. Erwin S. Smith, in the year 1910, isolated a species of *Fusarium* from discoloured vessels of diseased material from Cuba, and named the isolated organism *Fusarium cubense*. Other investigators have investigated the disease from time to time, but it appears that the results have been somewhat lacking in accuracy.

The disease has a very general distribution throughout the tropical regions of the world. In the West Indies it has been reported from Jamaica, Cuba, Porto Rico, Trinidad, and Barbados, and there is no reasonable uncertainty as to the identity of the disease. No doubt this disease is present in other islands of the West Indies, but on account of the limited extent of the banana industry in them it has not yet been reported. In Central America the disease is widespread, being especially virulent in Costa Rica: it has also been reported from Mexico. It first attracted wide attention in Panama early in the present century, and in Surinam the disease is notorious for its destructive nature and widespread occurrence. Evidence that it exists in India is fairly conclusive, and it is probably present in Australia and the Dutch East Indies. That it was introduced into the Hawaiian Islands from Costa Rica seems certain, since the outbreak of the disease there quickly followed the first importation of Gros Michel banana plants from Costa Rica.

The promiscuous shipping of plants from a common source into the various countries of Central and South America and the West Indies has been probably responsible for the wide distribution of the disease in tropical America. The intensive cultivation of bananas on the same land year in and year out, for export purposes chiefly, has resulted in the disease becoming steadily worse in districts where this is practised. Where bananas are grown in a desultory way for home consumption, the disease may be present, but is never serious.

As early as 1910 this disease was regarded as one of the

most important fungus diseases of cultivated plants in the American tropics. The extent of the industry which it threatened may be gauged from the estimate that American consumers pay at least \$200,000,000 annually for bananas; and although the late war has somewhat checked the exportation of this fruit to European countries, it is considered that the consumption of bananas in those countries will soon rival that of the United States. It must also be remembered that the home consumption of bananas in some tropical American countries is of more importance than the export trade. For instance, the city of San Juan, Porto Rico, alone consumes about 3,000,000 dozen bananas per annum, and for hundreds of thousands of Porto Ricans it is one of the main articles of diet.

When such an industry is threatened by a widely distributed and apparently infectious disease, it can be well understood that banana-planters have reason to be alarmed. During the past ten years the money loss in the cultivation of bananas in Panama and Costa Rica has been estimated to have been many millions of dollars.

In Surinam a serious effort was made in the year 1906 to establish an export industry in bananas. By 1910 every field under the Gros Michel variety was affected, and many planters were ruined.

Last year the disease was almost universally prevalent in the western part of Cuba in plants of a local variety which is most esteemed in the Havana market, but is not exported.

Jamaica has not suffered any great loss from this disease, due in part to the vigilance of the Government, which has established a quarantine on all affected areas in the island, but also undoubtedly to its climate and soil, which are quite different from those in Central America, where the disease is rampant.

Apart from pecuniary losses as a result of this disease, owing to loss of trade, there are three other classes of losses which may briefly be mentioned—(1) injury to the fruit, (2) destruction of immature plants, and (3) depre-

ciation of the value of the land. With regard to the first, if a bunch of fruit is produced, it is apt to be small, and is always rejected by the inspectors. With regard to the second, immature plants die in enormous numbers before any fruit is produced, and only rarely is a marketable bunch obtained from an infected field. The third type of loss—namely, the depreciation in value of the land—is due to the fact that the causal organism of the disease may remain for long periods in the soil, and finally increase to such an extent that bananas can no longer be grown.

SYMPTOMS OF THE DISEASE : EXTERNAL

In a field where only occasional and isolated cases of the disease are found, indicating that the soil has not yet become thoroughly infected, the affected plants are not apt to exhibit any external signs of the disease until after the bunch has started to form. A typically diseased plant first shows a yellowing of the lower or outer leaf-blades and petioles. The transition from the normal dark green colour of the leaf to a vivid yellow is usually sudden and startling, and proceeds from the margin inwards. Its appearance to one familiar with the disease is unmistakable, and not apt to be confused with any other trouble. This yellowing of the outer or lower leaves is a practically certain symptom, especially if, as is usually the case, it appears when drought symptoms are not to be expected. There is no risk of confusing it with the normal fall of the lower leaves. In a healthy plant the older leaves gradually and regularly die off from below upward, with only a gradual transition in colour from dark green to brown.

The leaves first attacked by the disease begin to wilt almost immediately. Within a day or two the fleshy leaf-stalk buckles, usually at a point 3 or 4 inches from the stem, and the leaf hangs from this point. Sometimes this buckling of the leaf-stalk or the large midrib

takes place at any point, out to the middle of the leaf-blade or beyond.

The leaf now rapidly withers and becomes brown, and the process is rapidly repeated in the other leaves, until the topmost or innermost leaf is reached. Finally this leaf droops and withers, and the plant stands for a few days or weeks with dry brown leaves rattling in the wind, until a puff of wind eventually sends it crashing to the earth, where it quickly rots, owing to secondary invasion by putrefactive organisms.

Another symptom of the malady, which may be seen in fields where the disease is of long standing, is a decided dwarfing or stunting of the whole plant. The stems of these stunted plants have a constricted or "hide-bound" appearance, and the leaves are curved or distorted, although they do not wilt so rapidly as those of larger plants, nor is the yellow colour so conspicuous.

Another symptom that frequently accompanies this stunted condition is a longitudinal splitting of the leaf-bases. Only the outer-leaf bases may be involved, or sometimes the split may extend to the centre of the stem, in which case it sometimes happens that the young leaf in the centre becomes diverted from its course upwards and grows out through the split.

If a bunch of fruit has formed on a diseased plant it will generally be found to be small. Development may be completely arrested after a few hands have been formed, and the individual fruits are small and pinched in at the calyx end. Occasional fruits scattered through such a bunch become yellow rapidly. The flesh is inclined to be pithy, acrid, and yellowish.

INTERNAL SYMPTOMS

Healthy banana tissue, when first cut open, is almost dead white. After a few minutes, especially if it has been cut with a steel knife, a purplish discoloration will appear uniformly distributed over the cut surface, due to the presence of oxidizing enzymes.

A section of a plant in the incipient stages of this disease presents quite a different appearance. Small dots and irregular lines of a yellowish or light-brown colour are to be seen, either distributed evenly over the whole cut surface or more frequently arranged in a band. Sometimes they are localized in one or more patches. These dots and threads are discoloured vascular bundles, and in later stages of the disease they become more numerous, their colour ranging from reddish to reddish-brown. At a quite advanced stage of the disease the vascular bundles change in colour from reddish-brown to purple or even black. Secondary rots have set in by this time, and as these rots are occasionally putrefactive, a disagreeable odour is sometimes given off.

Unmistakable evidence of the disease may be found also in the roots. Blackened roots close to the bulb, and extending into its diseased portion, are frequently found. This condition has been proved to be due to the organism causing the disease.

CAUSE OF THE DISEASE

This causal organism is a fungus, to which the name *Fusarium cubense* has been given. It is a typical member of the genus *Fusarium*, and exhibits near relationship to other species, notably *F. vasinfectum*. On account of its constant association with the disease the ability of *F. cubense* to cause the wilt has been assumed for some time. Dr. Brandes seems to have proved most convincingly, by a series of experiments which he records, that there is no doubt any longer that *F. cubense* is the cause of the Panama or wilt disease of bananas.

There are good grounds for assuming that the fungus excretes substances that are poisonous to many plants. It would seem, for instance, from the results of an experiment with cotton seedlings, that these are liable to infection and destruction when planted in soil heavily infested with the causal organisms of the Panama disease.

It appears that this aggressive parasite is known to attack only four or five of the hundreds of varieties of bananas.

DISSEMINATION OF THE DISEASE

As was noted in the first part of this article, owing to the carelessness of man this disease has been widely distributed by the planting of diseased suckers. If there were no other method of spreading the disease, it might be restricted to the progeny of originally diseased plants. Unfortunately, however, Nature has provided for an almost unlimited dissemination of the disease-causing organism to new localities under the proper conditions in the following ways:

The fungus produces innumerable spores on both surfaces of the leaf-blade, on the leaf-stalk, or even on the leaf-bases, apparently at any time of the year, the governing factors being the stage of the disease and the high atmospheric humidity or abundant rainfall.

These microscopic spores are easily dislodged, when dry, by the wind, and carried in all directions on slight currents of air, as they are extremely small and light. How far these spores may be carried by the wind without losing their vitality is not known, but theoretically a distance of many miles is possible, so that it may be assumed that the only practical limit in their dissemination by wind agency is their desiccation death-point.

In the tropical rains, which are so common in many banana-producing countries, the water frequently accumulates on the surface of the ground so rapidly that it is not easily absorbed, but runs in sheets or streams for considerable distances. There can be no doubt that this affords a ready means for the dispersal of the spores for short distances.

It has been abundantly proved that the fungus may remain alive in the soil in some form or other for long periods of time. It has also been proved that the organism is capable of growing in the soil. It is evident, therefore,

that if healthy bulbs are planted on such soil they will probably become infected. This leads to the consideration of another method of distribution of the fungus—namely, that mud carried on the feet of men and animals, or on the wheels of vehicles, may serve as a medium for dissemination of the fungus for great distances.

Insects may act as carriers, but there is no definite information on this point, and probably it is of little importance.

Infected banana leaves are frequently found among the "trash" used for protecting bunches when they are packed for transport to the steamers. This trash is often carelessly thrown about at various points along the route, and has probably aided in the distribution of the fungus.

ECOLOGY

The severity and the spread of this disease are strikingly correlated with certain well-defined weather conditions. Wet weather, especially if it is characterized by driving rains conducing to movement of surface water, is apparently a factor of considerable importance in the dissemination of the disease-producing organism. In Porto Rico, for instance, shortly after the rainy season has set in, there is a decided increase in the number of apparently new cases, and more rapid progress of the disease in plants already infected. Laboratory experiments show that the spores are very subject to injury by desiccation. Since the surface of the soil becomes very hot and dry during the dry season, it is unlikely that spores deposited thereon would survive. Another reason may be that the young fleshy roots, which are especially susceptible to infection, are not developed during the dry season, but push out from the rhizome in large numbers after the rains have set in.

In arid regions, where irrigation is necessary for the successful production of bananas, the disease is unknown. No case has been observed in the drier districts of southern Porto Rico, southern Jamaica, or northern Colombia.

In such regions the intense heat and dryness of the surface of the soil would make the survival of the wind-borne spores impossible. In southern Jamaica the soil becomes so hot and dry that planters invariably set the bulbs with about 1 foot of the "stem" still attached, so that this succulent stem, when it rots, will furnish moisture for the young shoot, and prevent its death by "boiling," as it is termed, though "baking" would be a more descriptive term. It is believed, therefore, that the disease need never be feared in these dry regions.

In countries where there are no well-marked wet and dry seasons—that is, where the rain is more or less evenly distributed throughout the year—the best conditions for the spread of the fungus exist. This is attested by the virulence of the disease in the banana districts of Panama and Costa Rica.

In Surinam, where the annual precipitation is very heavy, and the rains are distributed over practically the whole year, the disease spread over the entire country in the short space of four years. In such regions it is not only highly infectious, but extremely virulent and aggressive.

CONTROL

The present knowledge of the life-history of the disease-producing organism leads to the conclusion that the elimination of the disease as a source of injury to banana plantations, in countries where conditions are favourable to it, cannot be based on an attempt to eradicate the parasite. Any direct method of attack, such as protecting the plants by the application of fungicides, or eradication of the parasite in the soil by any method now in use, is out of the question. Sterilization of the soil is not economically practicable at the present price of bananas. Selection of disease-free bulbs is of value only where they are to be planted in soil which is not already infected. Control measures for this disease, as for other diseases of plants, would naturally group themselves under one or more of

four headings, namely, exclusion, protection, eradication, and immunization.

1. *Exclusion*.—Exclusion of diseased plants or other infected material by means of legislation would only be of value—(1) in countries where the disease is not present, but in which conditions are such as favour the disease; (2) in similar regions where the disease is not yet firmly established; (3) where it is partly held in check by climatic conditions.

This last division would include Jamaica, Porto Rico, and perhaps Cuba. Laws with respect to such quarantine already exist in Jamaica. Besides regulations to prevent the introduction into the island of any new source of infection, it is required by law that any person occupying land on which plants infected with wilt disease exist must give notice of the same to the Director of Agriculture, who then directs that the treatment prescribed by law be carried out. This consists of the destruction by fire of the diseased plant or plants, and other plants around them within a distance of 22 yards, after which the infected area is fenced in, and a local quarantine established for one year or more at the discretion of the Director. Investigation of the life-history of the parasite shows that these laws are amply justified. Even, however, in places where such measures are applicable, they appear only calculated to alleviate the situation until some other method may be found to eliminate the disease.

2. *Protection*.—Protection may be defined as the interposition of some effective barrier between the susceptible part of the host and the inoculating germs of the disease. As has been mentioned above, the susceptible parts of the banana plant are below the surface of the ground. Any method of attack, therefore, similar in principle to the spraying of the parts above ground by fungicides, is of no value.

3. *Eradication*.—Practically all efforts so far made in attempting to control this disease have been directed along the lines of eradicating the parasite.

The first principle of crop sanitation is to avoid planting infected bulbs, which invariably give rise to diseased plants. The necessity for selecting healthy bulbs for planting cannot be too strongly impressed upon banana-growers.

When a diseased individual is detected in the field, it should be immediately rooted out and destroyed by burning; otherwise it becomes a menace to surrounding plants, on account of the production and dispersal of disease-producing spores. Heedless neglect of any such diseased plant is bound to produce a harvest of new cases.

Eradication of the organism in the soil by allowing the land to remain fallow, rotation of crops, disinfection of the soil, mulching, flooding, and other methods, have been tried, but none has yet been found effectual.

The longevity of the organism is not definitely known, but it has been isolated from land which had not been planted to bananas for five years.

It has been found in studies on this disease that steam sterilization of the soil was very effective, but it is needless to say that under plantation conditions this method is impracticable.

4. *Immunization.*—The conclusion is arrived at that there is only one solution to the problem of the control and final eradication of the disease, and that is by the development of resistant strains of desirable varieties of banana.

Experiments have been started in this direction at the Porto Rico Agricultural Experiment Station. Although it is too soon to make definite statements as to the results, the indications point to a successful issue. It has been observed that an occasional plant growing in badly infected areas would resist the disease and produce good bunches of fruit, and give rise to healthy suckers. Such healthy plants had been surrounded by diseased ones for many generations. Suckers of these healthy plants have been removed to a specially prepared field artificially inoculated as heavily as possible. The progeny of any plants that

survive will be subjected to the same treatment. If they in turn survive it will be assumed that they can withstand the disease under any conditions, and they will be propagated and distributed as immune strains. It is recommended that similar experiments be started with commercial varieties in the countries where bananas are grown for export.

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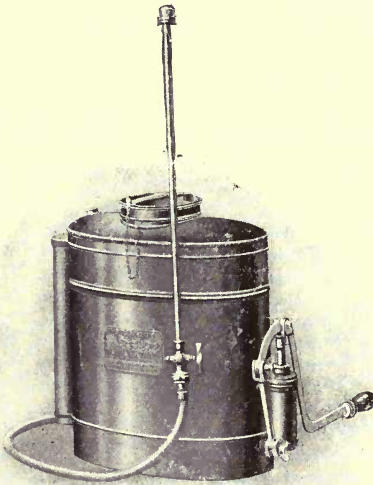
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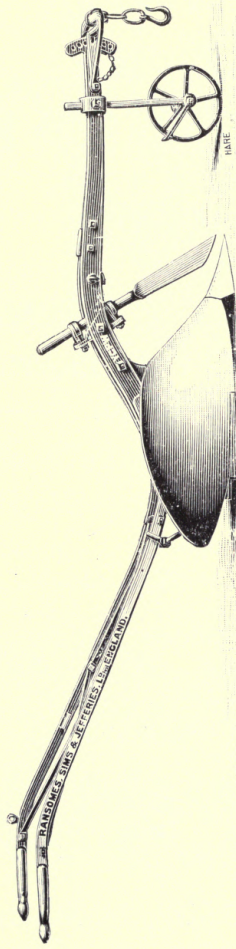
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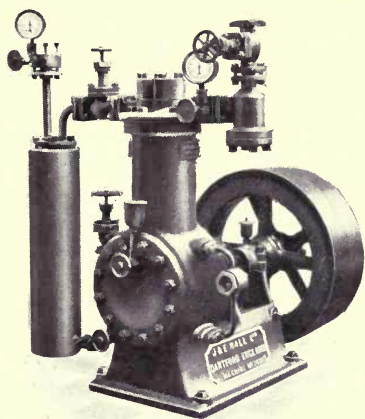
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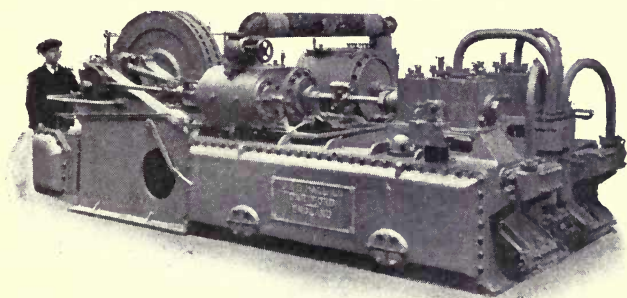
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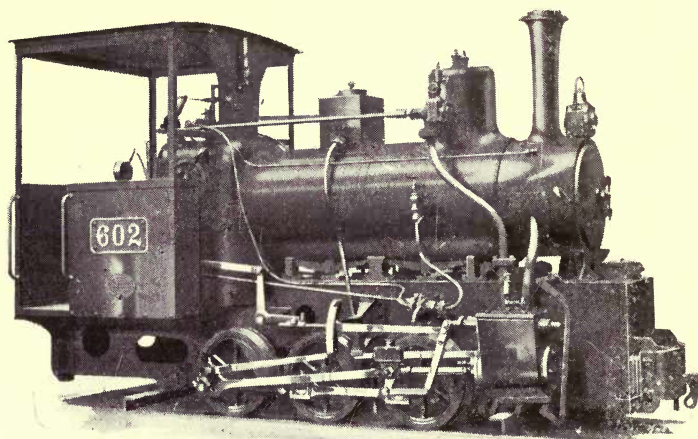
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